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Our quality commitment:

As reassurance that we are committed to Quality, Environmental and Health and Safety best practice, we are certified to:

EN61010-1 2010 (EU Directive 2014/35/EU Low Voltage Directive)

EN61326-1 2013 (Electromagnetic Compatibility Directive 2004/108 (EC)

Restriction of Hazardous Sunstances Directive 2011/65/EU

ISO 9001 05/3608 UKAS 120

OHSAS 18001 14/2457 UKAS 120

ISO 14001 12/4926 UKAS 120

We are members of the British Educational Suppliers Association, bound by our membership to follow the code of practice for safety, quality and suitability.

As a member of the British Quality Foundation we demonstrate our strong commitment to process improvement, to bring you the best in both quality product and service.

We are members of the United Nations Global Compact which means we adhere to their values of human rights, labour standards, the environment and anti-corruption.

How to choose the right Power Supply for your laboratory needs.

For cost-effectiveness, the Bench Power Supply is our best seller, although locking power supplies will save on repeated component damage.

The digital display on the College Power Supply allows more accuracy and is therefore suitable for GCSE work and further education.

The table below details more specific options relating to your applications.

Power supply units	Current (A)	Voltage (V)	Output control	Outputs	Limit lockable	Protection	Other features
Bench	Continuous of 8.5	1-13	STEPPED	a.c. Or d.c. (unsmoothed)	NO	Triple - T1A slow blow fuse, high speed electronic trip and thermal	
Lockmaster	Continuous of 8.5	1-15	STEPPED	a.c. Or d.c. (unsmoothed)	YES	Triple - T1A slow blow fuse, high speed electronic trip and thermal	
Ranger	Continuous of 8.5	0-15	VARIABLE	a.c. Or d.c. (unsmoothed)	YES	Triple - T1A slow blow fuse, high speed electronic trip and thermal	Both a.c. and d.c. can be used simultaneously provided combined do not exceed 8.5A
College	Continuous of 8.5	0-25	VARIABLE	a.c. Or d.c.	NO	Triple - T1A slow blow fuse, high speed electronic trip and thermal	Internal capacitor (2200µF) for smoothed output, Digital display and functions for voltage (V) and current (I)
E.H.T.	Maximum of 2mA	0-5kV	VARIABLE	d.c, second with 50MΩ and auxiliary 6.3V a.c. (1A)	NO	T1A slow blow fuse, and thermal	Independent earth terminal
Electromagnetics	10	1-0-1 a.c. and 2 d.c.	FIXED	a.c. Or d.c.	NO	T1A slow blow fuse, and thermal	Both a.c. and d.c. can be used simultaneously provided combined do not exceed 10A

Meters	Range	Inputs	Features				
Microvoltmeter	100µV - 1V	4mm plug sockets or B.N.C socket	Input diode protection Auto-zero, accuracy of ±5% of full scale deflection				
Picoammeter	100pA - 1mA	4mm plug sockets or B.N.C socket	Auto-zero, accuracy of ±1% of ttvfull scale deflection				

Signal Generators	Range (Hz)	Output control	Outputs	Waveforms	Features	Protection	
Bench Signal	10Hz - 100kHz	VARIABLE	Low power: High impedence (100Ω) signal	Sine and Square	Internal speaker, ground socket, Square wave rise is better than 0.25µs	Time delay fuse T500mA 250V	
Power Signal	0.1Hz - 110kHz	VARIABLE	High power: Low impedence signal (1Ω) and High impedence (100Ω) signal	Sine, Square, Triangular and TTL	Internal speaker, ground socket, amplitude and frequency modulation, Aux. input signal modulation	Time delay fuse T500mA 250V	

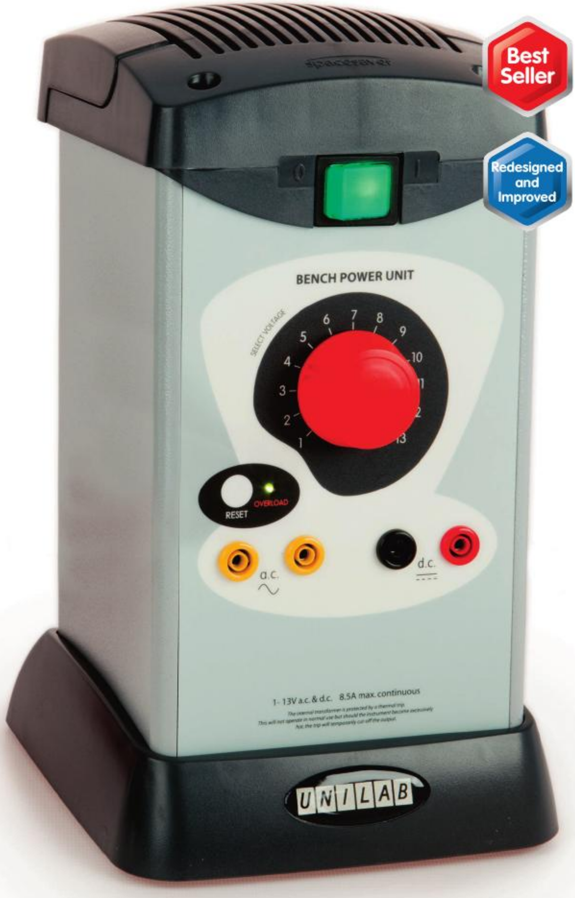
Our Own Design

Practical Information

BENCH POWER UNIT

Our most popular general purpose power supply.

- Output voltage selected by rotary switch in 1V steps up to 13V
- Long switch lifetime - switch voltage safely at full load without switch contact arcing
- Continuously rated output of 8.5A, a.c. or d.c.
- Internal fan for cool-running under load
- Fully protected secondary, by high speed, resettable electronic trip
- Slow-blow fuse protection for primary
- Additional thermal trip protection for transformer



Recommended for general-purpose laboratory and workshop use by students.

Provides 0-13V a.c. or unsmoothed d.c. in 1V steps at a maximum current of 8.5A. Both a.c. and d.c. outputs may be used simultaneously provided the combined output does not exceed 8.5A. Internal heavy-duty relays enable voltage to be switched whilst on full load without switch-contact problems thus giving a long switch lifetime.

The internal, quiet-running fan will hardly be noticed but it reduces the already low thermal stress in the unit still further, ensuring long life of the instrument. Triple protection is provided by a resettable electronic overload trip, thermal transformer trip and slow-blow fuse on the primary.

Dimensions:
Width: 175mm
Depth: 190mm (including cable clips 206mm)
Height: 298mm
Mass: 4.8kg

F4G85458	each **£107.99**
F4R06058	pack 5 **£512.99**

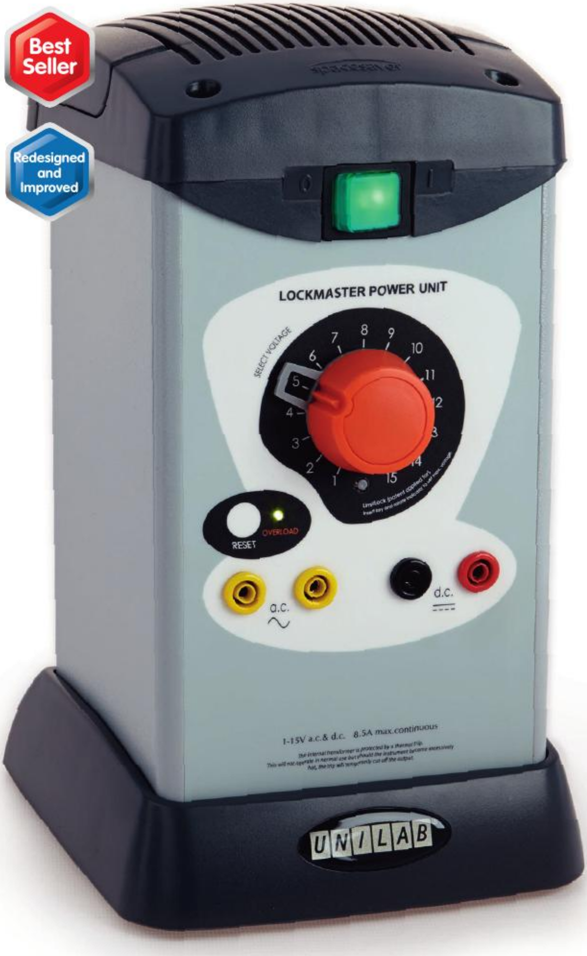
Handle snaps up and down - Spacesaver is easily and safely carried with one hand.

Electronic overload (indicated by LED changing from green to red) with push button reset.

IEC cable retainer ensures leads remain attached to units.

Best Seller

Redesigned and Improved



Our Own Design

Practical Information

LOCKMASTER POWER UNIT

- Output voltage selected by rotary switch in 1V steps up to 15V
- Long switch lifetime - voltage can be switched safely at full load without switch contact wear
- Continuously rated output of 8.5A, a.c. or d.c
- Adjustable, maximum voltage lock
- Internal fan for cool-running
- Fully protected secondary by high speed, resettable electronic trip
- Slow-blow fuse protection for transformer primary
- Additional thermal trip protection for transformer

Recommended for general-purpose laboratory and workshop use, particularly in situations where voltage-sensitive components may be damaged by over-voltage.

Provides 0-15V a.c. or unsmoothed d.c. in 1V steps at a maximum current of 8.5A. Both a.c. and d.c. outputs may be used simultaneously provided the combined output does not exceed 8.5A. Internal heavy-duty relay switching enables voltage to be switched whilst on full load without switch-contact problems; ensures long switch lifetime. The internal, quiet-running fan will hardly be noticed but it reduces the already low thermal stress in the unit still further, ensuring long life of the instrument. Triple protection is provided by resettable electronic overload trip, thermal transformer trip and slow-blow fuse on the transformer primary.

The maximum voltage that the unit can be adjusted to can be locked to a setting chosen by a teacher (or technician) using a key provided. Now the control knob can be adjusted up to the new setting but no further and protects voltage sensitive components such as light bulbs and motors from damage through over-voltage.

Dimensions:
Width: 175mm
Depth: 190mm (including cable clips 206mm)
Height: 298mm
Mass: 4.8kg

F4G85469	each **£113.50**
F4R06059	pack 5 **£539.99**

Electronic overload (indicated by LED changing from green to red) with push button reset.

Limitlock - insert key to release lock and rotate indicator to new maximum setting. Remove key to lock setting - knob will adjust no further than new setting.

Handle snaps up and down - Spacesaver is easily and safely carried with one hand.

Our Own Design

Practical Information

RANGER POWER UNIT

A continuously variable power supply that many teachers choose in preference to a switched unit.

- Output voltage variable by rotary control knob up to 15V
- Continuously rated output of 8.5A, a.c.or d.c.
- Adjustable, maximum voltage lock
- Internal fan for cool-running
- Fully protected secondary by high speed, resettable electronic trip
- Slow-blow fuse protection for primary
- Additional thermal trip protection for transformer

The Ranger is the preferred option for general-purpose student use, where a continuously variable supply is required and where the ability to lock the maximum voltage is desirable.

Provides continuously variable, 0-15V a.c. or unsmoothed d.c. at a maximum current of 8.5A. Both a.c. and d.c. outputs may be used simultaneously provided the combined output does not exceed 8.5A. The maximum voltage, that the unit can be adjusted to, can be locked to a setting selected by a teacher (or technician) using a key provided. The unit has a quiet-running fan that reduces heat build-up when running at heavy load for long periods of time. Triple protection is provided by resettable electronic overload trip, thermal transformer trip and slow-blow fuse on the primary.

Dimensions:

Width: 175mm.

Depth: 190mm (including cable clips 206mm).

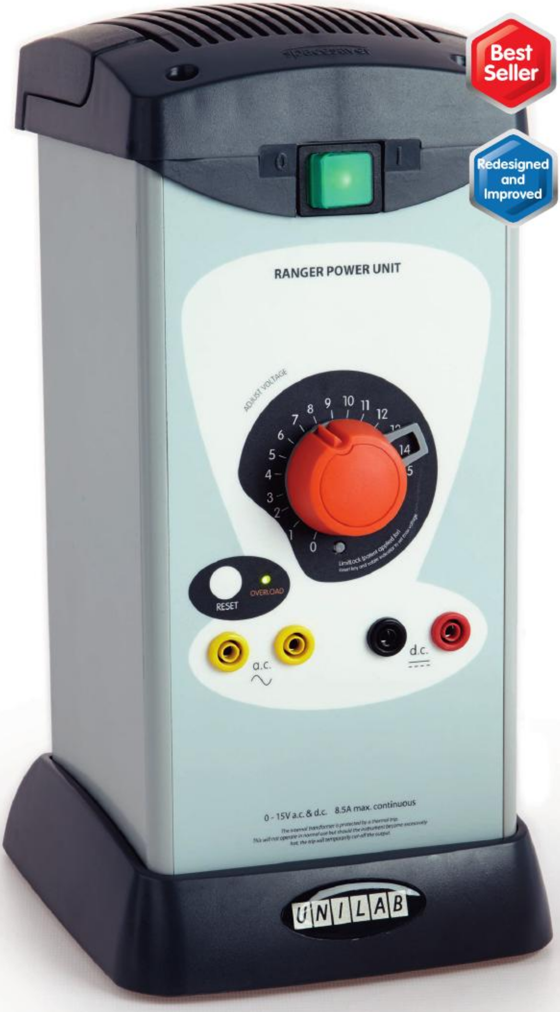
Height: 341mm.

Mass: 5.4kg.

F4G85471	each **£149.99**
F4R06060	pack 5 **£719.99**

Best Seller

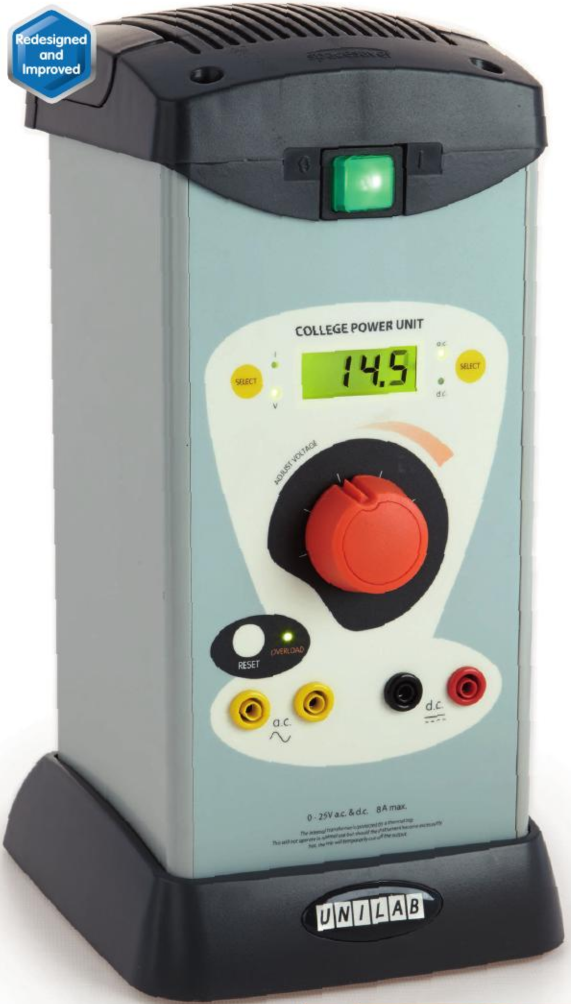
Redesigned and Improved



Electronic overload (indicated by LED changing from green to red) with push button reset.

IEC cable retainer ensures leads remain attached to units.

Redesigned and Improved



Our Own Design

Practical Information

COLLEGE POWER UNIT

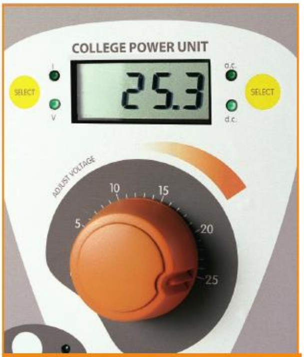
A very popular, advanced, continuously variable power unit now with improved specification and with all the advantages of the Spacesaver case.

- Output voltage variable by rotary knob up to 25V
- Continuously rated output of 8.5A, a.c. or d.c.
- Internal fan for cool-running
- Digital display of voltage or current for both a.c. and d.c.
- Fully protected secondary by high speed, resettable electronic trip
- Slow-blow fuse protection for primary
- Additional thermal trip protection for transformer

The College Power Unit is a versatile, high specification power unit appropriate for demonstration purposes and for use by students in advanced level courses. Provides continuously variable, 0-25V a.c. or d.c. at a maximum current of 8.5A. The d.c. supply is smoothed by an internal 2200μF capacitor. The a.c. and d.c. outputs can be used together provided the combined current does not exceed 8.5A. By depressing a button switch, a.c. or d.c. output voltages are displayed on a large LCD display. A second button enables current or voltage to be selected. An internal fan keeps temperatures down when running at full load. Triple protection is provided by a resettable electronic overload trip, thermal transformer trip and slow-blow fuse on the primary.

Dimensions:
Width: 175mm
Depth: 190mm (including cable clips 206mm)
Height: 391mm
Mass: 5.9kg

F4G85483	each **£229.99**
F4R06061	pack 5 **£1104.99**



Continuously variable up to 5kV. Socket facilitates shrouded or standard leads.

Handle snaps up and down - Spacesaver is easily and safely carried with one hand.

Info

EHT POWER UNIT

EHT Power Unit is suitable for electrostatics experiments and for driving vacuum devices such as the Teltron Tubes (excluding the double fine beam gas filled tube).

- Continuously variable, 0 - 5kV at a maximum current of 2mA
- Second output with 50MΩ safety resistor
- Auxillary output, 6.3V a.c. at 1A
- Digital, back-lit display indicating EHT output voltage
- Sockets suitable for standard 4mm plugs or shrouded plugs

The adjustable 5kV output is fully isolated and a backlit, digital meter displays the output voltage. An independent earth terminal is provided which enables the negative or positive side of the output to be earthed. There is a mandatory requirement to limit output current to 2mA and for this reason, there is a safety resistor between the smoothing capacitors and output. In addition to the main EHT output, there is a further output linked by a 50MΩ resistor. This provides an EHT output appropriate for electrostatics experiments with a short-circuit current of 60μA. An auxiliary output is provided to drive cathode heaters, etc.

Dimensions:

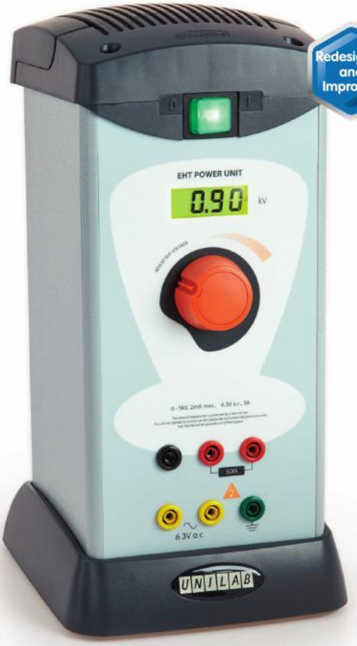
Width: 175mm.

Depth: 190mm (including cable clips 206mm).

Height: 341mm.

Mass: 4.8kg.

F4G85495	each **£232.99**
F4R06063	pack 5 **£1139.99**



Redesigned and Improved

Our Own Design

Info

ELECTROMAGNETICS POWER UNIT

- Output voltage 1-0-1V a.c. and 2V d.c. at 10A
- Unit tolerates short-circuits
- Transformer protected by a thermal trip and slow-blow fuse
- Internal fan for cool running

A power supply specially designed for investigations into magnetic fields associated with electric current and similar experiments, where high current at low voltage is required, and the power supply must tolerate short-circuits.

Dimensions:

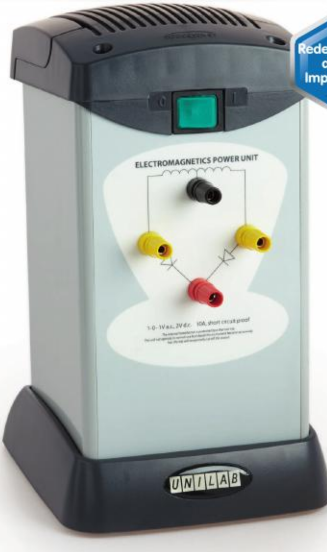
Width: 175mm.

Depth: 190mm (including cable clips 206mm).

Height: 298mm.

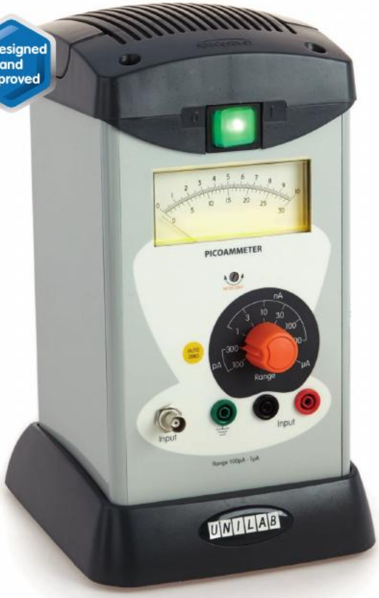
Mass: 3.4kg.

F4R01306	each **£84.99**
F4R06062	pack 5 **£414.99**


ELECTROMAGNETICS POWER UNIT
1-0-1V a.c., 2V d.c. 10A, short circuit proof
UNILAB

Redesigned and Improved

Redesigned and Improved



Practical Information

SPACESAVER PICOAMMETER

- A very popular instrument housed in the Spacesaver case
- Detect currents as low as 1pA on the 100pA range
- Input voltage up to 5kV
- BNC socket for shielded lead
- Auto-zero facility

The Picoammeter is designed to measure very small currents and has nine ranges from 100pA to 1μA, selected by rotary switch. The instrument has a large moving coil meter, with an auto-zero facility. Input is by way of 4mm sockets or a BNC socket, for very low currents where a shielded lead is preferred. Input impedance is 10MΩ and voltages up to 5kV will not damage the unit.

Suggested uses include: measurement of ionisation currents, reverse currents of silicon diodes, resistivities of wood and paper, capacitor leakage current, etc.

Dimensions:

Width: 175mm.

Depth: 190mm (including cable clips: 206mm).

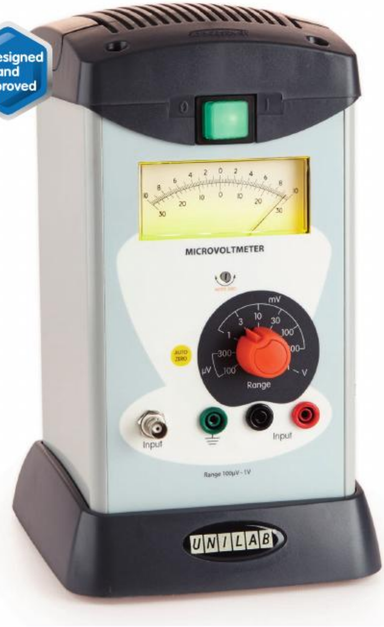
Height: 298mm.

Mass: 2.7kg.

F4G85756	each **£179.99**
F4R06064	pack 5 **£879.99**

Our Own Design

Redesigned and Improved



Practical Information

SPACESAVER MICROVOLTMETER

- An effective and robust replacement for a centre-zero galvanometer
- 10 MΩ/V on 100μV range - considerably better than a spot galvanometer
- Auto-zero facility

The Microvoltmeter is an effective and robust replacement for a spot galvanometer, with 9 ranges from 100μV to 1V. The input resistance of 1kΩ gives 10MΩ/V on 100μV range, which is considerably better than a spot galvanometer. The instrument has a large moving coil meter, with auto-zero facility. Input is by way of 4mm sockets or a BNC socket, for very low voltages where a shielded lead is preferred. Suggested uses include: measurement of e.m.f.s from thermocouples, strain gauges and Hall Effect devices, electromagnetic induction measurements, etc.

Dimensions;

Mass: 2.7kg.

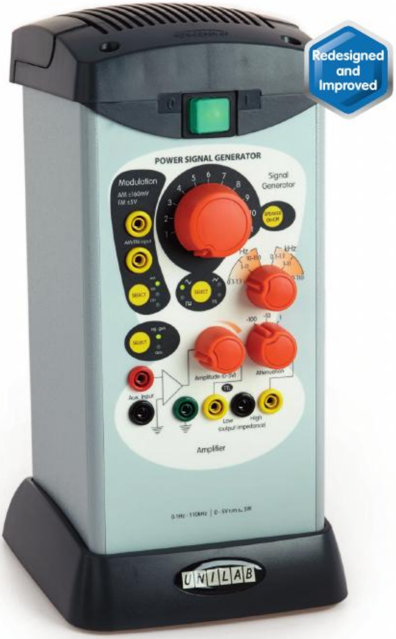
Size: 175 x 190 (206 inc. cable clip) x 298mm.

F4G85768	each **£159.99**
F4R06057	pack 5 **£782.99**

Practical Information

POWER SIGNAL GENERATOR

- Sine, square, triangular and TTL waveforms available
- Amplitude and frequency modulation
- Instrument amplifier for amplification of signal generator output or external input
- Continuously variable output, low and high impedance
- High impedance output may be attenuated by a factor of 10 or 100 to provide fine control over low level outputs
- Built-in speaker for audible frequency range



The power signal generator is a versatile device, enclosed in our SpaceSaver case. It can produce a wide range of signals, from 0.1Hz to 110kHz, with an output power of up to 5W. There are low and high impedance outputs, with the low impedance protected by a time delay fuse. The unit features an internal speaker that can be turned on and off, and can be used to demonstrate the range of human hearing (from 20Hz up to 20kHz).

Frequency control is via a 6 position decade dial and a large continuous dial which controls a multiplier from x1 to x11. There are also dials to control amplitude from 0V to 5V, and attenuation on the high impedance output. Buttons control the shape of the function (sine, triangle, square and TTL), turn the internal speaker on or off, select the modulation mode, and between auxiliary or internal signal.

There are inputs for signal modulation by an external signal, which can be a.m. or f.m., for exploring different types of radio signals, and an auxiliary input for amplification of an external signal instead of the internal function generator, such as from a microphone or music player.

This instrument is ideal for powering large speakers, and is necessary for driving the vibration generator to explore vibrations and waves.

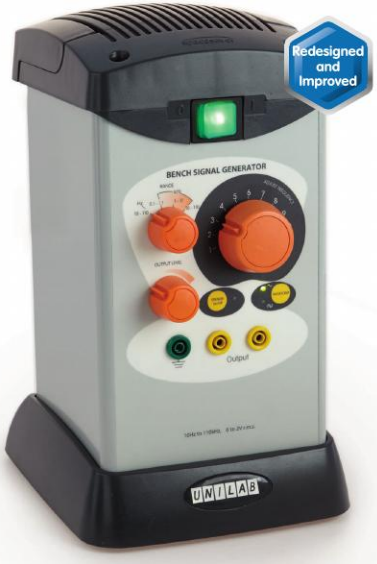
F4G85793	each **£289.99**
F4R06056	pack 5 **£1399.99**

Our Own Design

Practical Information

BENCH SIGNAL GENERATOR

- 10Hz to 110kHz in four decade ranges selected by rotary switch
- Sine or square waveform selected by push switch with LED indication
- Sine wave distortion 0.5% typical
- Square wave rise time better than 0.25µs
- Output 0-2V rms (5.6V peak to peak) open circuit
- Continuously variable, uncalibrated amplitude control
- Built-in speaker: switch-selected with LED indicator
- Floating output: with separate Earth terminal
- Mains switch: rocker switch with indicator light
- Not suitable for driving a vibration generator



A robust, basic instrument for general laboratory use with all of the advantages of the Spacesaver case. Output signal is adjustable over the full audio range and beyond with a low level of distortion. Coarse frequency control is by way of a rotary-switch spanning four decades and a calibrated tuning dial provides for fine frequency setting. Output level is continuously variable up to a maximum of 2V r.m.s. under open circuit conditions. An audible signal from the built-in speaker can be selected by depressing a front-panel membrane switch. A similar switch enables selection of sinusoidal or square waveform, the status indicated by LEDs.

Dimensions;

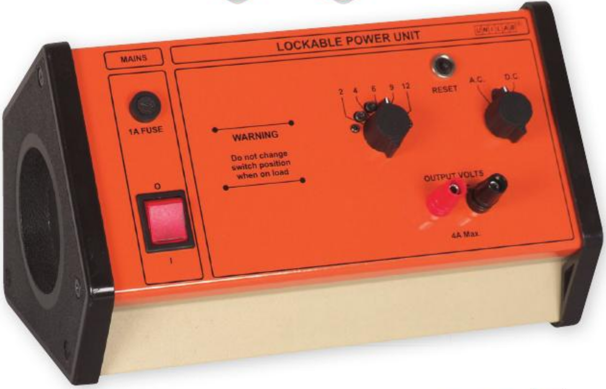
Size: W175 x D190 x H298mm.

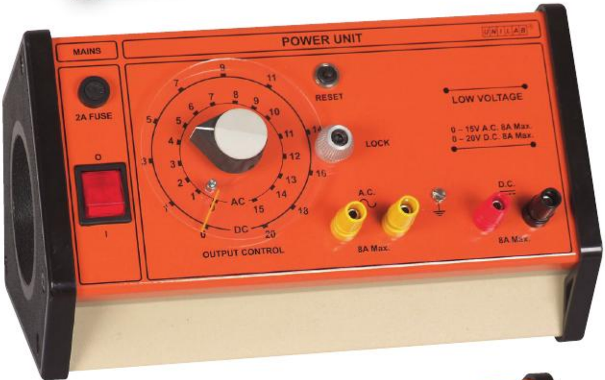
Mass: 3.1kg.

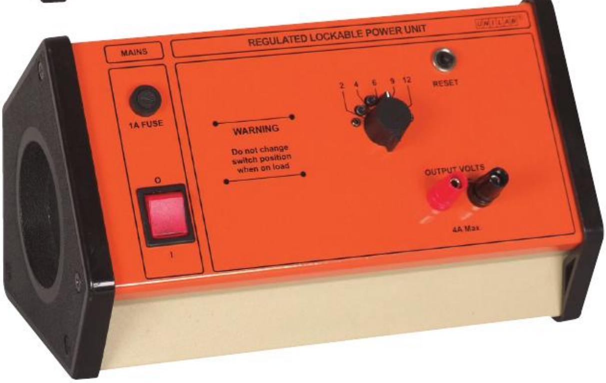
F4R01308	each **£164.99**
F4R06065	pack 5 **£779.99**

Great Value

Economy Science






MAINS
REGULATED LOCKABLE POWER UNIT
UNILAB
1A FUSE
WARNING
Do not change switch position when on load
2 4 6 9 12
RESET
OUTPUT VOLTS
4A Max.
O
I

This everyday range of power supplies offers solid support for your lab by being affordable, robust and no nonsense! They are simple, easy to use and represent great value for money.

For the majority of your experiments this range is perfect.

Safe, reliable and competitively priced!

Retro Basic PSU

The entry level power supply in the Unilab Retro range. The Lockable Power Unit provides a.c. or d.c. at 2, 4, 6, 9 or 12 volts, at up to 4 amps. This unit is well suited to everyday power requirements, such as basic electricity, ray optics boxes and immersion heaters. The voltage is selected using a five-position switch, and can be locked either at a particular voltage, or within a range of voltages, by way of hex socket screws surrounding the selector switch. An Allen key is provided for the teacher or technician to set the desired locks.

The form of the output is set by a separate switch, either a.c. or unsmoothed, unregulated d.c. Two shrouded 4mm sockets provide the output, and the shroud can be partially unscrewed for other types of connection, such as bare wires. a.c. and d.c. are output from the same sockets, and never simultaneously, preventing students from connecting the a.c. and d.c. outputs together.

The unit has two in-built layers of protection. The first is a thermal trip on the secondary circuit, with a reset button for when the problem load has been disconnected. The second is a 1A mains fuse, accessed from the front panel, on the primary circuit.

F4R04365	each **£87.99**
F4R05930	pack 5 **£382.45**

Retro Ranger PSU

This is the workhorse of the Unilab Retro range, offering continuously variable a.c. up to 15 volts, and d.c. up to 20 volts, at a combined current of up to 8 amps. This unit is ideal where high power is required, such as high-power quartz lamps or for powering simultaneous experiments.

The voltage is selected by a large knob on the front panel, with dual scale around the outside to indicate a.c. and d.c. voltage setting. It can be locked at a limit by way of an adjustable transparent Perspex disc around the control knob which is secured by a hex socket. An Allen key is provided for the teacher or technician to set the desired locks.

The supply offers simultaneous a.c. and d.c. output from dedicated pairs of shrouded 4mm sockets, and the shroud can be partially unscrewed for other types of connection, such as bare wires.

The unit has two in-built layers of protection. The first is a thermal trip on the secondary circuit, with a reset button for when the problem load has been disconnected. The second is a 2A mains fuse, accessed from the front panel, on the primary circuit. Allen key included.

F4R04366	each **£133.99**
F4R05931	pack 5 **£593.95**

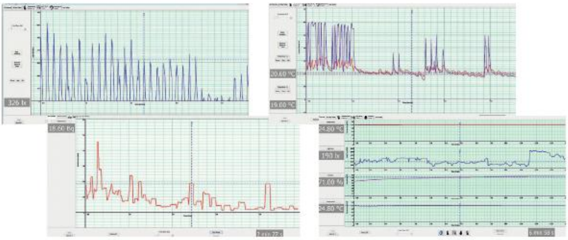
Retro Regulated PSU

The most sophisticated of the Unilab Retro range, the Regulated Lockable Power Unit offers smooth, regulated d.c. at 2, 4, 6, 9 or 12 volts, at up to 4 amps. This unit is for specialist requirements, such as electronics, or where a constant voltage is required under variable load. The voltage is selected using a five-position switch, and can be locked either at a particular voltage, or within a range of voltages, by way of hex socket screws surrounding the selector switch. An Allen key is provided for the teacher or technician to set the desired locks. The power is output from shrouded 4mm sockets, and the shroud can be partially unscrewed for other types of connection, such as bare wires. The unit has two in-built layers of protection. The first is a thermal trip on the secondary circuit, with a reset button for when the problem load has been disconnected. The second is a 1A mains fuse, accessed from the front panel, on the primary circuit.

F4R04367	each **£138.99**
F4R05932	pack 5 **£620.95**

A

B



A Logbook Wireless GLE (Including Software)

A comprehensive, easy to use data logger with built in temperature, light and sound sensors.

- Graphics screen enables graphical visualisation of data during a recording and from saved files
- Direct USB connection to the computer
- Four channel input
- Auto sized meter and graph screens giving a large font meter for one and two channel use
- Snapshot and Auto recording modes for remote recordings
- Extended memory option allowing remote recordings of up to 44,000 data points
- Bluetooth Wireless connectivity

F4R05745	each **£309.99**
F4R05911	pack 5 **£1449.95**

B Logbook Graphing Secondary Software

Through simple use of the drop down menus and toolbars students are able to carry out a range of investigations. Logbook Graphing offers a new concept in sensor technology by offering the ability to both meter and record from a number of combination sensors. Logbook Graphing functionality ranges from a simple triggered recording through to the comprehensive area under graph plotting and calculation via a cursor. Also incorporated in Logbook Graphing is Datamass, which allows integration (using a USB or an RS232 connection) with a range of compatible balances. Auto plug and play is available with a Logbook USB cable and Ohaus balances.

F4R05783	each **£159.99**

Practical Information

- Easy to connect; auto connection through serial ports and Bluetooth enabled
- Easy to log; quick start logging available
- Easy to save; save files as .xls, .lmz or as an editable graph
- Easy to control; one-press repeat log, slider X and Y axis control
- GPS enabled; create Google Map or Google Earth 3D visualisations

Great Value

SAVE £90 On Individual Components!

Innovation

Great Value

SAVE £115 On Individual Components!

This bundle can be used for both intermediate and advanced Physic applications, including investigations into static and kinetic friction, the speed of sound and electrical energy. It provides a wide range of sensors which can be used to log, analyse and present information, as well as a Logbook and software.

This bundle includes a great mix of sensors that can be used both inside and outside the classroom. The logbook can be operated cordlessly, making it ideal for completing field work studies. Two Logbooks are also included, along with the relevant software.

A Physics Bundle

The versatile Physics Bundle offers great value for money and includes:

- Logbook GLE Wireless Data Logger
- Dual Range Force Sensor
- Accelerometer Sensor
- 10Amp Current Sensor
- 2x Lightgate Sensors
- Pressure Sensor
- Sound Sensor
- Temperature Sensor
- 20V Voltage Sensor

F4R05785 pack **£764.99**

B Fieldwork Bundle

A comprehensive Fieldwork Bundle that includes:

- 2x Logbook GLE Wireless Data Loggers
- IR Distance Sensor
- Advanced Flow Sensor
- Advanced Light Sensor
- Nitric Oxide Sensor
- Dissolved Oxygen Sensor
- Sound Sensor
- Sulphur Dioxide Sensor
- UV Irradiance Sensor
- Nitrogen Dioxide Sensor

F4R05786 pack **£1699.99**

C Infrared Temp Sensor

Ideal for measuring the temperature of remote objects. It works by pointing the unit at the object being measured, pressing the button and reading the temperature using one of the Logbook range of data loggers. Most suitable for taking snapshot recordings of temperature. Remote infrared based temperature measurement from - 17°C to 550 °C.

F4R05805 each **£74.99**

A Distance IR Sensor

Ideal for carrying out investigations of motion and displacement. It uses reflective technology and ideally the target should be white. It is most accurate in the range 200 to 1000mm. A number of these sensors can be used in the same room as they do not interfere with each other, provided they are at least 2m apart.

Also use this sensor to measure Velocity.

F4R05803 each **£104.99**

B Voltage Sensor (20v)

The sensor is designed to measure variations in voltage, both positive and negative, work from DC up to 10KHz and can be used with Current sensors anywhere in a circuit with a supply voltage range of less than 24 volts. Range ± 20 V, res 0.05 V.

Also use this sensor to measure:

- Power
- Energy
- RMS Voltage
- Current (if circuit resistance is known)
- Resistance (requires a current sensor)

F4R05748 each **£44.99**

C Spirometer Sensor

Consists of a low pressure sensor, ±1 KPa, and a Spirometer mouthpiece. It can be used either to measure breathing rate, or to assess the function of a subjects lungs. The Spirometer mouthpiece is part of the accessory pack for the 1KPa Pressure sensor, both of which are supplied. Range: ±1 KPa, res 0.002kPa. Minimum recommended recording interval is 10ms.

F4R05918 each **£149.99**

D Pulse Sensor

This sensor can be used either with a standard chest belt to measure heart rate during exercise or with an ear/finger clip for before/after exercise. Wireless communication from the belt strap ensures reliable measurements. The pulse sensor measures pulse rate from 0 to 240 beat per minute.

F4R05792 each **£74.99**

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A Dual Range Force Sensor

The dual force sensor has 2 ranges. The low range is ideal for measuring the impacts of model cars on the sensor plate and the impulse generated by a small object such as a ping pong ball bouncing. The high range is suited to measurement of large impulses and forces associated with heavier objects.

Ranges:

- Low range sensor ±8 N, res 0.01 N
- High range sensor ±50 N, res 0.2 N Minimum recommended recording interval is 1 ms

F4R05790 each **£104.99**

B Oxygen Atmospheric Sensor

This sensor is designed to measure the oxygen content of air and investigating respiration. Range: 0 to 30%, res 0.1%.

Minimum recommended recording interval is 100ms.

Also use this sensor to measure:

- Velocity

Applications include:

- Transpiration of plants
- Oxygen content of breath

F4R05746 each **£179.99**

C 3 Axis Accelerometer Sensor

This sensor calculates the magnitude of the acceleration vector or the directional acceleration for the selected axis depending on the mode selected.

Ranges:

- 0 to 250ms-2 res 0.5ms-2
- 0 to 60ms-2 res 0.1ms-2
- 0 to 15ms-2 res 0.02ms-2
- X axis ±11.5ms-2 res 0.05ms-2
- Y axis ±11.5ms-2 res 0.05ms-2
- Z axis ±11.5ms-2 res 0.05ms-2

Minimum recommended recording interval is 1 second.

Also use this sensor to measure:

- Velocity
- Distance

Applications include:

- Study of Newton's Laws (using dynamics cart)
- Motion acceleration in a vehicle
- Acceleration experienced by a person on a roller coaster

F4R05747 each **£129.99**

D Radioactive Sensor

This sensor has a variable sample rate depending on the radiation level. At low radiation levels the sample period goes up to 8 seconds. At higher radiation levels the sample period will automatically decrease giving a faster response. Range: 0.1 to 1000 counts s-1, res 2% of reading.

Minimum recommended recording interval is 100 ms.

F4R05802 each **£229.99**

E Humidity Sensor

The sensor uses the latest semiconductor sensor technology to provide accurate and reliable temperature compensated humidity measurements in all school laboratory applications.

Specification:

- 0 to100% (non-condensing)
- res 1% Built-in temperature compensation
- Minimum recommended recording interval is 1 second

F4R05794 each **£59.99**

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A Current ±10A Sensor

Designed to measure variations in current, both positive and negative. They work from DC up to 10 KHz and can be used together with other Logbook current and voltage sensors anywhere in a circuit with a supply voltage range of less than 24 volts.

Also use this sensor to measure:

- Charge
- Power
- Energy
- Voltage (if circuit resistance is known)
- RMS Current
- Resistance

F4R05793	each **£44.99**

B Pressure (Gauge -110 - 700 KPa) Sensor

Ideal for the investigation of gas laws. It measures absolute pressure so that in a normal room environment it will measure the atmospheric pressure which is approximately 100kPa. It can therefore measure both a vacuum and higher pressures. When used with the Volume sensor it is easy to investigate the relationship between pressure and volume. Range: -110 to 700 KPa,res 1KPa. Minimum recommended recording interval is 10 ms.

F4R05796	each **£114.99**

C CO_2 Sensor

Measures atmospheric CO2 levels at a sensitivity which is rapid enough to monitor variations over a few minutes. The cell has a life of approximately 2 years; replacements are available. Range: 0 to 100,000 ppm, res 1.5% of reading. Minimum recommended recording interval 1 sec.

F4R05791	each **£119.99**

D Volume Gas Sensor

This unique sensor makes investigating of gas laws and titrations much more simple. There are two interchangeable syringes to make this sensor both a 60cc volume sensor and a volume gas syringe.

Specification:

Volume 60cc

- 0 to 60cc, res 0.1cc

Volume Gas Syringe:

- 0 to 55cc, res 0.1cc

F4R05797	each **£154.99**

E pH Probe Sensor

Measures pH levels from pH0 to pH14. Allows the user to calibrate to pH7 remotely, and to perform 1 or 2 point calibration to any pH when using Datadisc. Range: 0 to 14pH, res 0.01 pH units. Minimum recommended recording interval is 1 second.

Also use this sensor to measure:

- Temperature compensated pH levels
- Ion concentration

Applications include:

- Investigate the chemistry of buffers
- Photosynthesis

F4R05795	each **£82.99**

A

Innovation

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A Temperature Sensor

This probe is designed for general use such as the temperature measurement of air, surface or liquids.

- Range -20 to 120°C, res 0.2°C
- Safe for use in all readily available classroom chemicals
- Minimum recommended recording interval is 10 ms for the temperature probe

F4R05787 each **£29.99**

B Advanced Light Sensor

The advanced light sensor can measure from 0.5 to 100,000 lux, with relative accuracy at all levels. It is ideal for experiments needing accurate quantitative results at all incident light levels. This sensor can select either fast or slow response modes.

F4R05788 each **£59.99**

C Sound Sensor

Suitable for investigating the sound level in normal working environments, and very low levels such as the dawn chorus. It has ranges for sound waves either in dB or in KPa. The sensor has a fast response: two sensors placed a few metres apart can be used to measure the speed of sound.

F4R05789 each **£57.99**

D Light Gate Sensor Kit

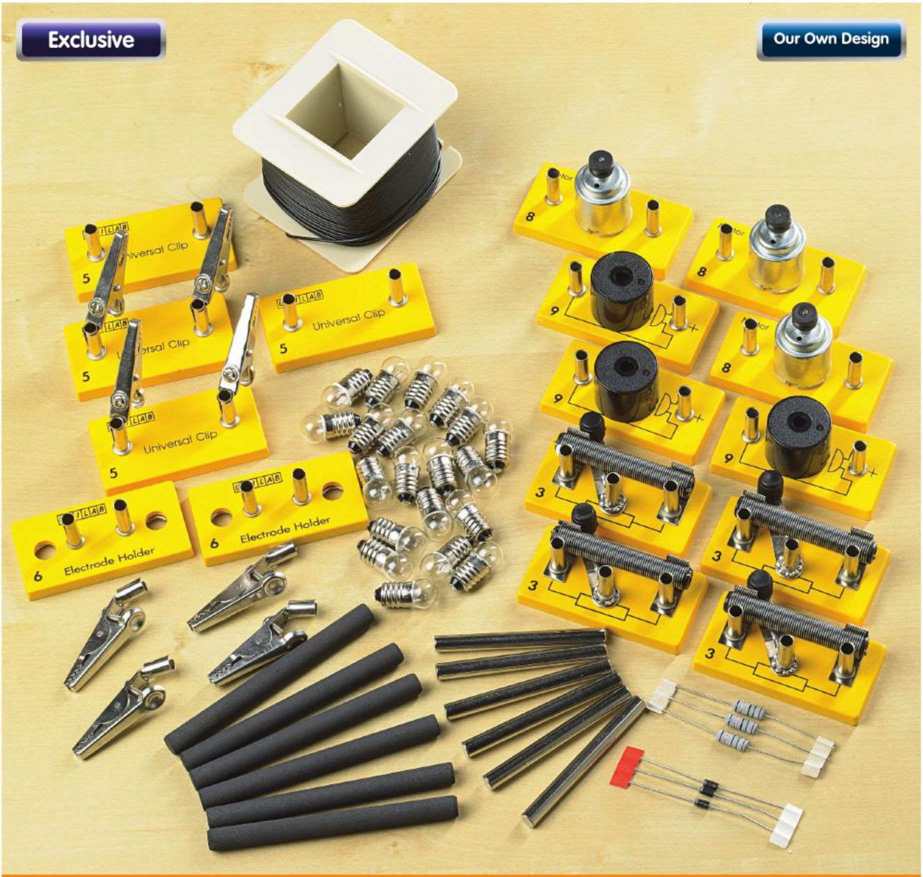
Using any air track the kit can be used to show conservation of momentum and energy in elastic collisions and conservation of momentum and change of energy in elastic collisions. Includes Datadisc Timing and 2 lightgates.

F4R05801 kit **£124.99**

Spares and Accessories

Sensormeter to Logbook Sensor Range Cable

F4R05806 each **£8.99**



Showing contents of Kit B

Primary Basic Electricity Kit

Designed as a resource for the teaching of introductory electricity, these kits include well structured instructional material and robust components mounted on tough, yellow plastic bases, each with two 4mm sockets. The panels are formed into circuits by connecting them together using 4mm stackable leads. Kit A is for a group of up to six students, while Kit B contains additional items and consumables that could be issued by teachers as required. Only one Kit B would be needed by a class.

A Teacher's Manual is included in Kit A that introduces each item of equipment and a range of tasks and investigations. Topics covered are bulbs and cells, switches, electromagnets, motors and buzzers.

Contents of Kit A:

- 6 cell holders (without cells)
- 6 bulbs in holders
- 3 press switches
- 3 two-way switches
- 18 connecting leads
- Primary Electricity Kit booklet.

Contents of Kit B:

- 20 replacement bulbs
- 4 variable resistors
- 3 motors
- 3 buzzers
- 2 electrode holders
- 3 diodes
- 3 fixed resistors
- 4 universal clips with 8 crocodile clips
- 6 steel rods
- 6 carbon rods
- Reel of plastic-coated wire

Both kits are supplied in a robust polystyrene box.

F4R03086	kit A **£57.99**
F4R03085	kit B **£107.99**

Helpful Hint

Light a lamp using a BEK single cell holder, one BEK lamp, a BEK Switch and two leads. Make the lamp brighter by adding a second cell holder and gently hold the lamp between finger and thumb. What do you feel? Two types of energy are produced by the lamp: heat and light. Use a magnifying glass to look at the filament inside the lamp. The filament is a very thin wire that glows white hot when electricity flows through it. Why don't the connecting wires (leads) get hot?

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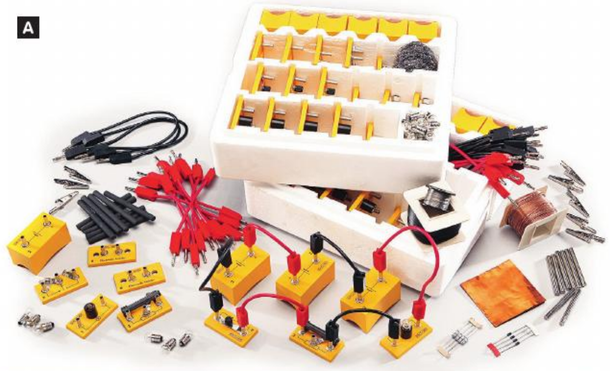

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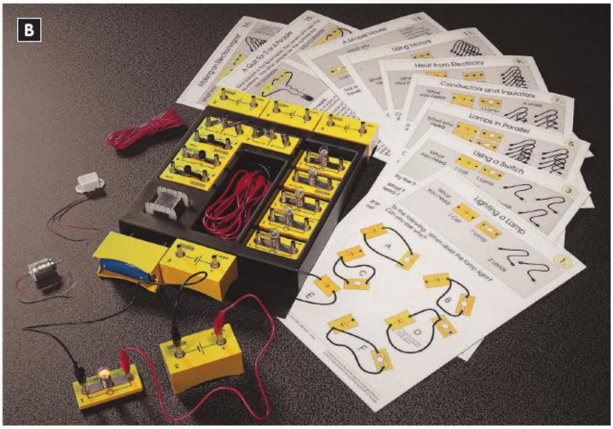

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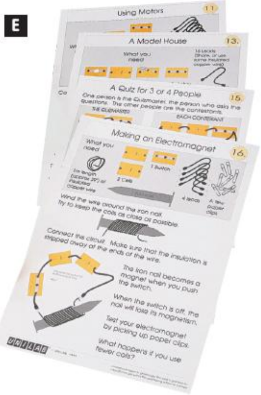

Set of 16 work cards

A Basic Electricity Kit (BEK)

The Basic Electricity Kit has been designed as a low-cost, attractive and flexible alternative to the circuit-board approach to pupil investigations into simple circuits. Each component such as a switch, rheostat, bulb holder etc., is mounted on its own individual plastic panel with 4mm sockets. The panels are then formed into circuits by connecting them together using 4mm stackable leads. Because this is real circuit making, the equipment will find uses throughout secondary school science curriculum. Each kit is supplied in 2 polystyrene trays which keep the units organised.

Contents:

- 12 cell holders (without cells)
- 20 bulb holders
- 40 bulbs (4.5V, 0.3A)
- 12 4mm leads red 100mm
- 12 4mm leads black 100mm
- 4 4mm leads red 250mm
- 4 4mm leads black 250mm
- 4 rheostat units
- 4 universal clips
- 8 crocodile clips
- 4 silicon diodes
- 4 fixed resistors
- 8 push switches
- 4 changeover switches
- 4 electrode holders
- 8 soft iron rods
- 12 carbon rods
- 50m copper wire bare 20swg
- 50g Eureka wire bare 34swg
- 50m insulated copper wire
- 1 sheet copper foil 150 X 150mm
- 1 pack steel wool
- 1 teacher's book
- 2 pupils' books
- 2 polystyrene storage trays

F4L25835	kit **£284.99**

B Elementary Basic Electricity Kit

An introductory circuit kit for children with workcards covering the following topics: Lighting a lamp, Using motors, Using a switch, A model house, Lamps in series and parallel, Making an electromagnet, Conductors and insulators, A quiz for three or four people and Heat from electricity. Components are mounted on bright yellow plastic bases, each with two 4mm diameter sockets. Contents: six cell holders, six bulb holders, six bulbs, three on/off switches, two two-way switches, buzzer, motor, reel of nichrome wire, ten crocodile leads. Supplied in a robust polystyrene box.

F4L12713	kit **£107.99**

C BEK Teacher's Book

The Teacher's Book gives enough background to help non specialists deliver successful activities at KS 1, 2 and 3.

F4R03087	each **£4.99**

D BEK Pupils' Book

The Pupils Booklet supports practical work at KS1 and 2 with real world examples and activities.

F4C62789	each **£4.99**

E Set Of Work Cards For Elementary Electricity Kit

A comprehensive set of sixteen workcards to complement the BEK. They cover lighting a lamp, brightness of a lamp, using a switch, lamps in series, lamps in parallel, lamps and switches, conductors and insulators, heat from electricity, short circuits, using motors, using buzzers, a model house, a model car, making an electromagnet and a fun quiz.

F4C62997	each **£15.75**

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A Rheostat (variable resistor)

Vary the current in a circuit using this rheostat. Supplied with 11Ω coil.

F4H30646 each **£9.60**

Rheostat Coil

11 ohms.

F4H30622 each **£2.25**

Rheostat Coil

15 ohms.

F4L01053 each **£2.75**

B Push Switch

Push Switch for BEK.

F4H30798 each **£6.20**

C Bulb Holder

Bulbs sold separately.

F4H30804 each **£2.45**

D Universal Clip

Holds components and materials for investigation.

F4H30839 each **£2.75**

Mixed Wire Pack

Pack of three wires of diameter 0.14, 0.20 and 0.28mm for investigation of resistivity, to be held in the Universal Clip.

F4H83328 pack 3 **£6.50**

E LED Red

Mounted red LED bulb with 4mm sockets.

F4R05627 each **£2.50**

F LED Green

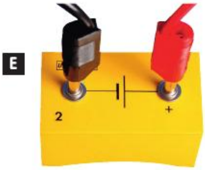
Mounted green LED bulb with 4mm sockets.

F4R05628 each **£2.50**

G Parallel Boards

One pair of parallel boards fo use with BEK.

F4R05626 pair **£4.50**



Exclusive

A Changeover Switch

F4H30828 each **£2.50**

B Mounted Motor

F4H30944 each **£9.60**

C Mounted Buzzer

F4H30749 each **£4.80**

D 3 Way Switch

F4H31286 each **£4.05**

E Cell Holder

Single cell holder with 4mm sockets, ingeniously moulded so a cell can only be inserted the correct way around. Takes one D cell. For use with either Basic Electricity Kit.

F4H79970 each **£2.30**

F 4 Cell Holder (BEK)

Takes 4 D cells. 4mm sockets enable different voltages to be selected.

F4H30658 each **£15.25**

G Electrode Holder

F4H79994 each **£4.20**

H Flashlamp Bulbs, Round

With M.E.S. cap; suitable for flashlamps, spotlights and panel lamps, etc. Supplied in packs of ten except for B8A56777 which is supplied singularly.

F4A56741 4.5V, 0.3A pack 10 **£5.99**

I Crocodile Clips

F4H30609 pack 10 **£5.15**

J Carbon Rods

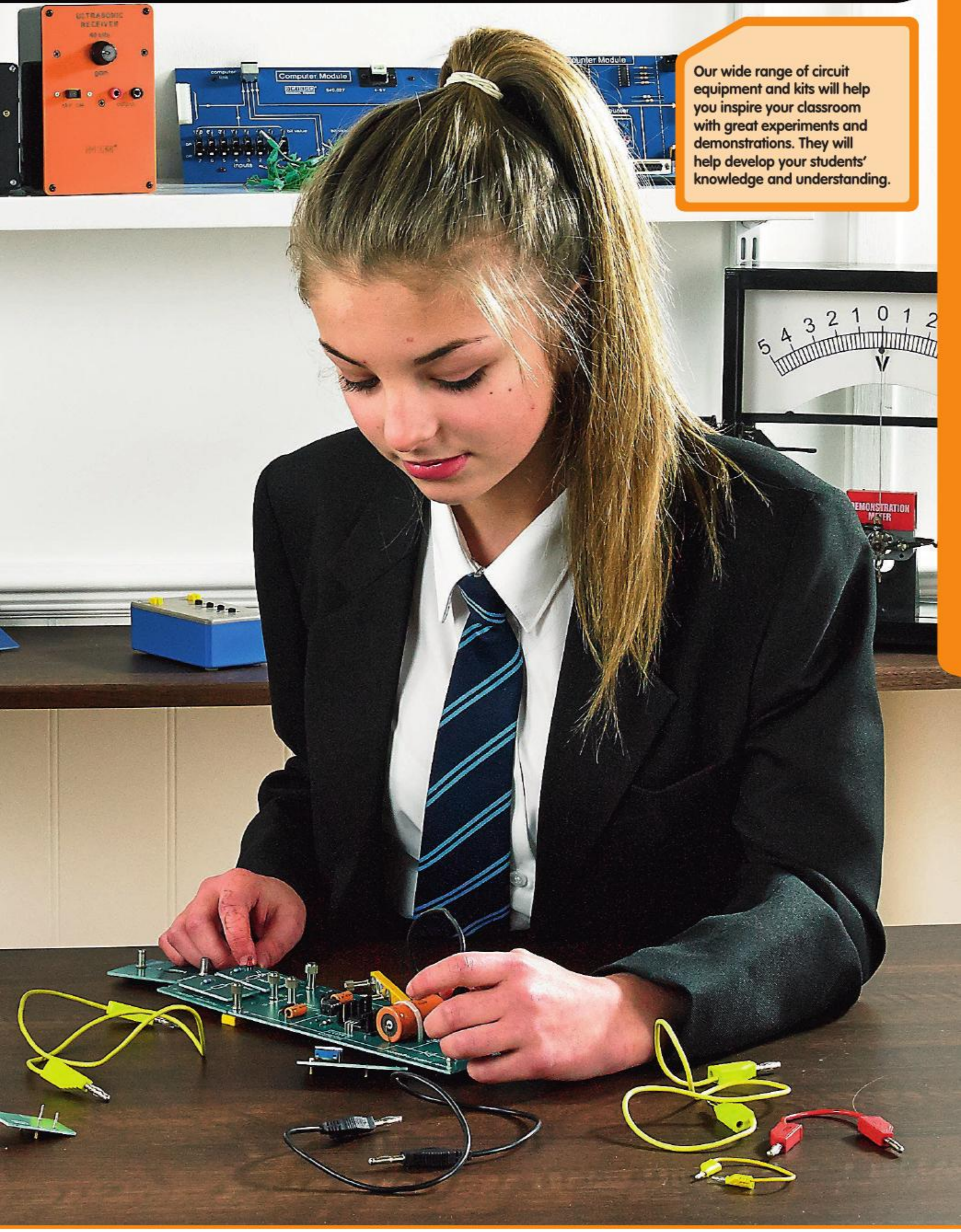
For electrode holder.

F4H31092 pack 10 **£16.50**

K Storage Box for BEK

Storage box for the Basic Electricity Kit.

F4H30579 each **£82.99**

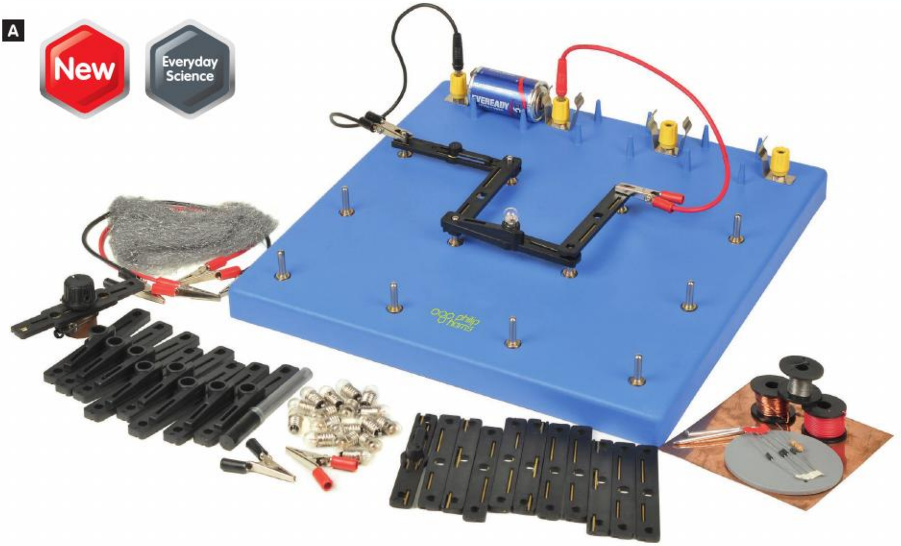


Our wide range of circuit equipment and kits will help you inspire your classroom with great experiments and demonstrations. They will help develop your students' knowledge and understanding.

A

New

Everyday Science



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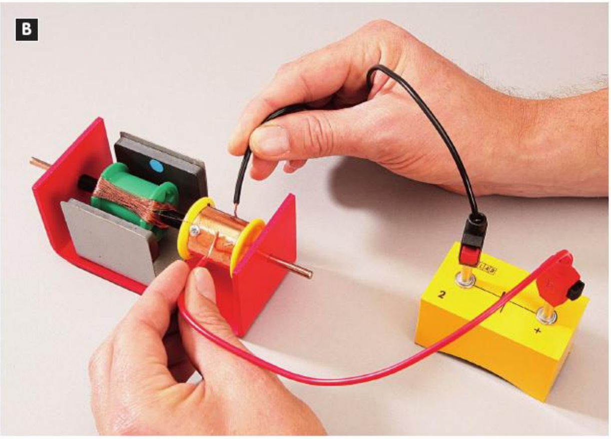

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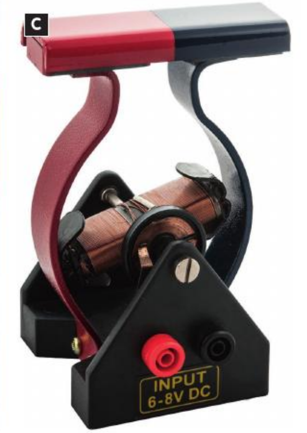

A Worcester Circuit Board

Contains a baseboard with terminal connections, set of high quality plastic connectors with metal inserts and with potentiometer and lamp holders and accessories units, enable a variety of circuits to be constructed quickly. Supplied with all accessories, without cells. Supplied with manual.

F4R06035	each **£129.99**

B Electric Motor Kit

A kit of components and materials that will allow a pupil to build a simple but effective two pole d.c. motor that will run well on voltages as low as 1.5V. This kit is designed to overcome the difficulties of obtaining a good electrical contact with the commutator, with minimum friction, in the brush system. This kit dispenses with the need to construct "permanent" brushes. Instead, the bared ends of two lengths of stranded flexible wire are simply held at either side of the commutator so that they apply gentle pressure under the control of the operator. The ceramic magnets supplied are marked for polarity so that Fleming's rule may be investigated.

All materials are provided and a set of teacher's notes is included.

F4A47934	kit **£32.99**

C Demonstration Electric Motor

A model of the simplest form of d.c. electric motor, having a 2-pole armature wound with enamelled copper wire, and a permanent magnetic field provided by a removable magnet. The construction of the model is completely open and all components are readily observable. A disc-type commutator is incorporated and external connection to the phosphor-bronze bushes is by means of a pair of 4mm sockets. The motor will operate on 3 to 6V d.c.

Height: 125mm.

F4L26086	each **£44.50**

11-13 Simple Circuit Modules

These modules may be used to construct simple circuits of the type normally implemented on, for example, a Worcester Circuit Board. They are intended to introduce younger pupils to some of the more familiar applications of devices and circuits, the main emphasis being on simple electrical circuit work.

The modules are 60 x 60mm and have 4mm plug connections.

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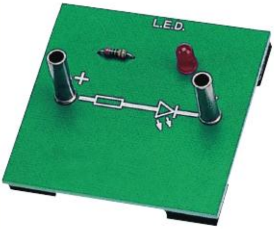

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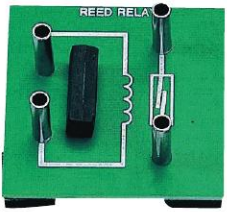

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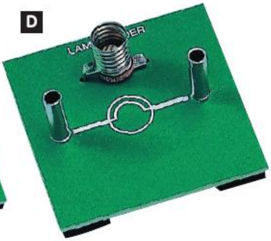

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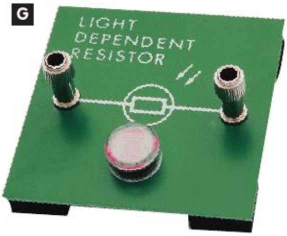

A LED Boards

Large light-emitting diodes with series resistors of 220Ω for p.ds up to 6V.

F4H27842	Red LED	each **£7.25**
F4H28366	Green LED	each **£7.50**

B Reed Relay

A current through the coil produces magnetism to cause the reed to switch another circuit; the reed contacts are protected from short circuit damage by a low-value series resistor.

F4H28147	each **£30.50**

C Motor

A low-voltage d.c. motor with series resistor to limit current consumption.

F4H27908	each **£23.50**

Buzzer

A low-current buzzer (approx 2mA).

F4H28019	each **£13.50**

D Lamp

4.5V, 0.3A bulb in a holder.

F4H27635	each **£8.70**

E Light Dependent Resistor Unit

A cluster of three ORP12s in parallel; resistance approximately 200Ω in room lighting to give greater sensitivity and control the current in a reed relay.

F4H28287	each **£15.99**

F Thermistor Unit

A cluster of 5 VA1108s in parallel; resistance approximately 200Ω at 90°C.

F4H28202	each **£10.50**

G Input Boards LDR

An ORP13, 4mm light dependent resistor; fully covered resistance of 10kΩ; in normal room conditions resistance of 250Ω approximately.

F4H27702	each **£9.25**

CROSS REFERENCE

4mm Stackable Plug Leads see page 97

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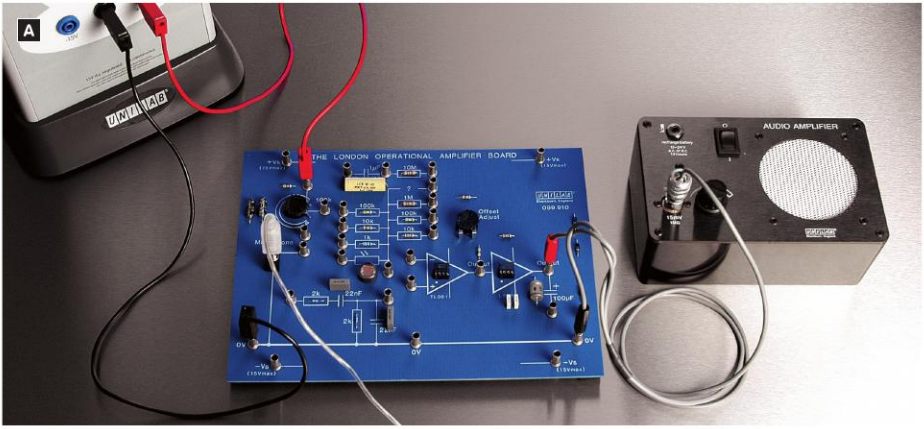

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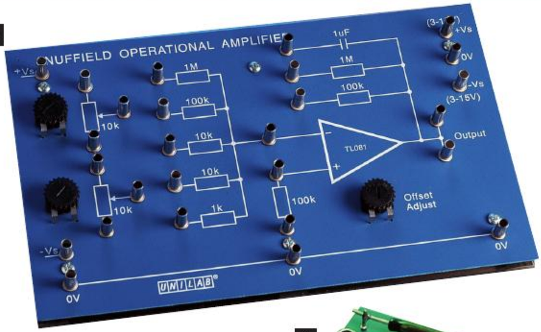

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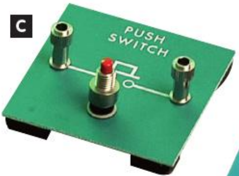

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A "London" Operational Amplifier

Has input devices such as an LDR, microphone input, 100kΩ potentiometer and 1μF capacitor. There are six resistors with space for an additional component. An offset control is included, plus a 1A power amplifier for loads eg. a loudspeaker, motor or lamp. A Wein network is included. Output can be fed through the power amplifier into a loudspeaker.

F4H29206 each **£44.99**

B Operational Amplifier

Arranged with 5 input resistors, 2 feedback resistors and capacitor, all selected by plug-in leads. An ofset control is also fitted. Two 10kΩ potentiometers allow input voltages to be varied continuously. Regulated power supply between ±5V to ±15V is required.

F4H28093 each **£38.99**

C Push Button Switch

F4H27660 each **£8.70**

D Reed Switch

A heavy-duty reed switch protected by series resistor; a magnet operates the switch.

F4H27970 each **£13.50**

E Variable Resistor

A 10kΩ linear potentiometer.

F4H28846 each **£20.50**

Low Value Resistor Board

Resistors of value 100, 1000 and 10,000Ω.

F4H28731 each **£6.70**

F Transistor Board

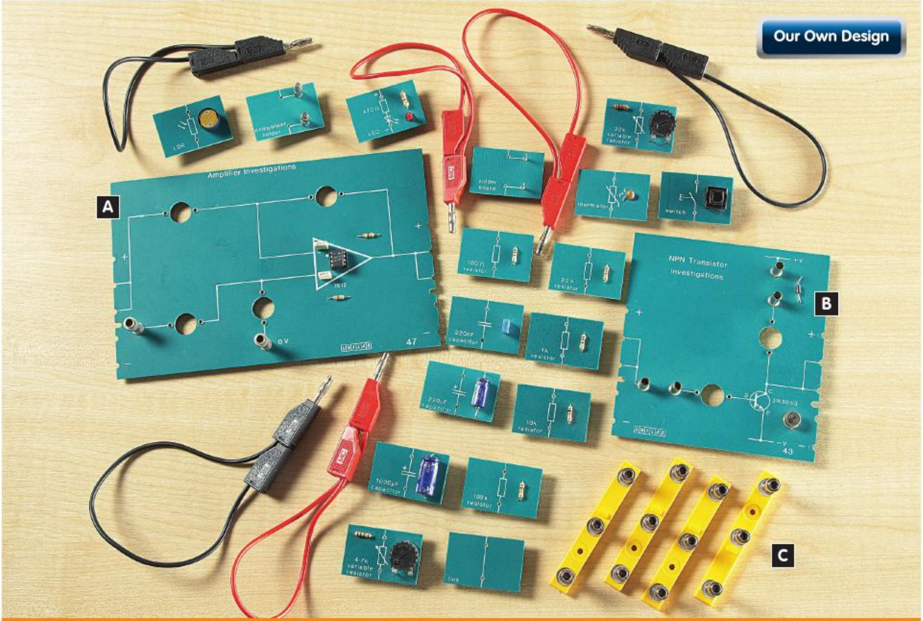
Based on an NPN TIP47 transistor with 10Ω base resistor and 100Ω collector resistor.

F4H28937 each **£14.50**

G S.P.D.T Switch

Single pole double throw rocker action switch.

F4H27933 each **£8.50**



Both kits include a Alpha Power Supply Regulator (for connection to any bench power supply 9 to 12V a.c. or d.c.)

A Alpha Operational Amplifier Investigations Kit

Operational amplifiers are common in many electronic devices. They amplify minute signals e.g. from a microphone to make them suitable for input to a power amplifier, or the signals from ECG sensors, to enable them to be displayed on a screen. This kit gives students an understanding of op amps, including input impedance and feedback, gain, amplification of d.c. and a.c. signals, saturation, differential mode, the use of a bridge circuit to detect and amplify very small changes – this has applications in the creation of sensors such as strain gauges. When used with a microphone, an Alpha Power Amplifier and small loudspeaker, a two stage audio amplifier can be constructed.

The manual (on CD) includes suggestions for extension work that involves discrete components and op amps, built on breadboard.

Item	Quantity
Alpha, amplifier investigations board	1
Alpha, potential divider	2
Alpha, 4.7k potentiometer panel	1
Alpha, component holder panel	1
Alpha, solder panel	1
Alpha, 100 OHM resistor panel	1
Alpha, 1k resistor panel	2
Alpha, 2.2k resistor panel	2
Alpha, 10k resistor panel	4
Alpha, 100k resistor panel	4
Alpha, 5k variable resistor panel	1
Alpha, 22k variable resistor panel	1
Alpha, link panel	2
Alpha, LDR panel	1
Alpha, thermistor panel	1
Alphalink (yellow)	4
Alpha OP AMP investigations manual (on CD)	1
F4R02923	kit **£161.99**

CROSS REFERENCE

For our range of batteries see page 100.

B Alpha Transistor Investigations Kit

The kit enables students to explore the behaviour of an NPN transistor, which is mounted on an oversize Alpha board. Component panels, carrying a variety of resistors, capacitors, a thermistor, LED and LDR, plug into sockets on the transistor board. Extra sockets allow for connection of meters to monitor current flow in the base and collector circuits.

Simple and complex circuits can be quickly constructed and tested, using Alpha links to attach external components and sensors to the input (base) and output (collector). The emitter of the transistor is connected to zero volts.

Example circuits include: potential divider, thermistor in a potential divider, using a transistor as a switch, light controlled switch, using a capacitor for time delay, time delay switch.

The Transistor Investigations board can also be used with other Alpha boards to create a simple oscillator, capable of producing audible tones via a small loudspeaker.

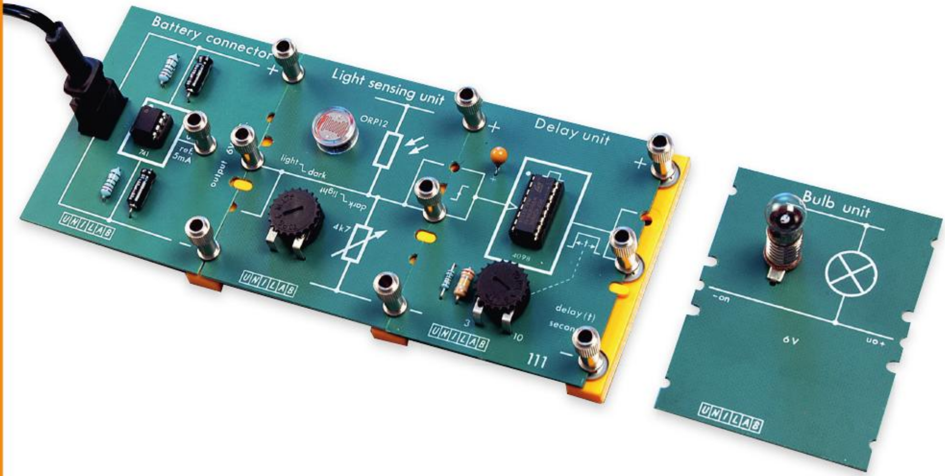
Item	Quantity
Alpha, transistor investigations, NPN	1
Alpha, potential divider	1
Alpha, 4.7k potentiometer panel	1
Alpha, component investigations	1
Alpha, component holder panel	1
Alpha, solder panel	1
Alpha, 100 OHM resistor panel	1
Alpha, 1k resistor panel	1
Alpha, 10k resistor panel	1
Alpha, 5k variable resistor panel	1
Alpha, 22k variable resistor panel	1
Alpha, thermistor panel	1
Alpha, switch panel	1
Alpha, LED panel	1
Alpha, LDR panel	1
Alpha, 1000uF capacitor panel	1
Alpha, 220uF capacitor panel	1
Alpha, 220nF capacitor panel	1
Alphalink (yellow)	3
Alpha transistor investigations manual (on CD)	1
F4R02922	kit **£144.99**

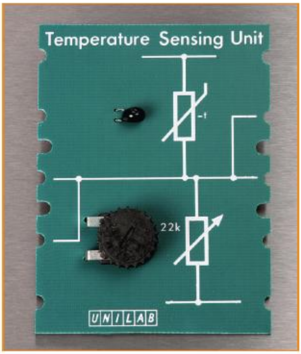
C Central Terminal, Yellow

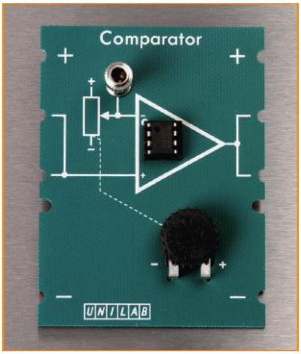
Central yellow terminal for Alpha boards.

F4H27519 each **£3.50**

Exclusive







Alpha GCSE Physics Students Kit

The Alpha GCSE Physics student kit (for one working group) has been designed to cover the common electronic content of all GCSE syllabuses.

Topics covered are; potential divider, characteristics of light - dependent resistor and thermistor, transistor as a switch and as a current gain device, logic gates (AND, OR and NOT). The use of sensing devices to control an output device provides an opportunity to apply their understanding of signals and simple signal processing, including conversion of a gradual analogue change into a digital on/off signal, for use in logic systems.

Contents:

1 x Alpha Power Supply Regulator Board
1 x Comparator
1 x Inverter
1 x Two Input OR Gate
1 x Two Input AND Gate
1 x Transistor Switch/Indicator
1 x Diode Unit
1 x Temperature Sensing Unit
1 x Rain Sensing Unit
2 x Switch Unit
1 x Light Sensing Unit
1 x Input Voltage Unit
1 x 100k Potentiometer
1 x Power Link Board
1 x Alphalink (Brown)
5 x Alphalink (Yellow)
1 x Buzzer Unit
1 x Bulb Unit

PLEASE NOTE: To power the system, the Alpha Power Supply Regulator Board is included. This takes 8 to 12V d.c. or a.c. from any bench power supply and converts it to a regulated 5V d.c. with a centre tap at 2.5V. It limits the current supplied to an Alpha circuit to 0.5A. It is the ideal way to power Alpha, virtually eliminating risks of accidental overload and incorrect polarity.

F4H76713	kit **£124.99**

CROSS REFERENCE

Bench Power Unit see page 5

Electronics made easy! Using the baseboard, circuits are built up by simply plugging in the modules. Each module has two or four 4mm plugs on its base, which connect through the groups of 4 sockets on the baseboard to adjacent modules. 4mm leads are used to bring in power and meters as required. The more complex functions, such as logic gates, have extra sockets on top of the modules, to take signals in.

A Electronic Plug-in Modules

A fixed 5V regulated power supply is recommended, but a variable regulated supply may be used with care. Meters for voltage and current in the ranges 0 to 5V d.c. and 0 to 10mA and 0 to 500mA d.c. Signals can be passed to an oscilloscope when that is appropriate.

Starting with basic component investigations, students can progress through Ohm's Law, capacitor discharge, diode and transistor characteristics, to create useful sensing and amplifying circuits. Then they can explore basic logic with the selection of single gates that can be combined to explore more complex logical solutions to problems.

Adding a signal generator and oscilloscope, students can explore the behaviour of a.c. signals when they encounter resistors, capacitors and inductors. Extension work is offered by the bridge rectifier and regulator modules, which can be used to create a functional regulated power supply.

Contents:

- Plug in baseboard with 24 "islands" of 4 interconnected sockets
- Passive components
- A selection of capacitors from 0.01uF to 1000uF
- Three inductors
- A selection of capacitors from 100 ohms to 470kohm
- Variable resistors 1k, 10k and 1M ohms
- Push button switches (4)
- SPDT switch modules (2)
- Active components
- Transistors (BC109 and 2N2222 – 2 of each)
- JFET, MOSFET, Triac, Diode, Zener Diode, Bridge Rectifier and Regulator modules

Logic components

- AND, NAND, NOR, NOT (inverter), OR and XDR gates

Sensors and outputs

- Thermistor, Light sensor, Piezo buzzer/sounder, Lamp in holder, Reed switch & magnet, LED module (4)

Size: base board 308 x 245 x 45mm Mass: 950g

Small component (2 plugs): 40g each

Larger component (4 plugs): 60g each

F4R03096 kit **£394.99**

B Resistance Unit

A handy 7-way resistance unit for low voltage circuit work and Ohm's Law investigations, offering a range of values: 1, 4.7, 10, 100, 1000, 10000 and 10000 ohms. Each resistor is connected to a pair of red and black 4mm sockets. They can be connected in series or parallel to support investigation of the "rules" for combining resistors.

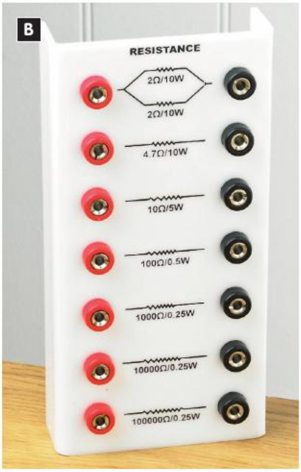
The maximum voltage allowed depends on the resistor value, and its power rating. Students should appreciate the need for some simple calculations when selecting a resistor value. The Notes For Use provides guidance.

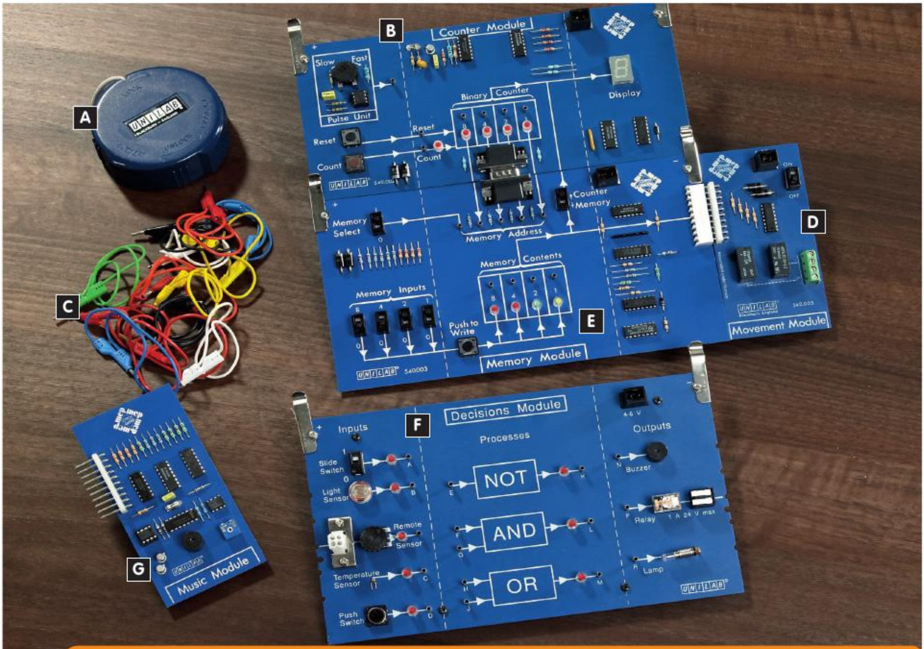
All resistors are rated at 0.25W

Maximum current: 250mA a.c. or d.c.

Size: 160 x 75 x 31mm Mass: 130g

F4R03097 kit **£13.99**





MFA - Microelectronics For All

MFA is one of the most popular and accessible microelectronics teaching packages. Based on the "input-process-output" model, the electronics board in MFA allow students to solve problems involving logic, counting, timing and sequencing.

A MFA Battery Holder for PJ996

This fits on top of a lantern battery and connects to MFA via a 50cm lead and keyed plug.

F4R03092 each **£8.50**

B MFA Counter Module

This unit develops the concept of binary numbers. The board counts and displays the number of pulses received, using LEDs and a hexadecimal seven-segment display. The counter can be clocked manually by push button or by connection to an on-board pulse unit. It can also count events from another board.

F4H28079 each **£59.99**

C 2mm Stackable Leads Pack

Includes 300mm black, 300mm red, 150mm black, 150mm red, 150mm yellow and 150mm blue. Suitable for all MFA experiments.

F4R05110 pack **£16.99**

D MFA Movement Module

The Movement Module carries two SPDT relays which switch on and off according to the 4-bit binary input from the Memory Module. The board and relays are powered from a separate 6V battery and MFA Battery Cap. The relays switch the battery voltage to provide forward and reverse control of the two motors on the Dodger Buggy.

F4H28883 each **£24.99**

E MFA Memory Module

With this board students investigate what is meant by an address in memory. When used with the Counter Module the memory chip provides two sets of sixteen locations, each of which can hold a 4-bit binary number. The data is also available at an edge connector, so that the Music and Movement Modules can be controlled by these stored instructions, as they are clocked through by the pulse unit in the Counter.

F4H28433 each **£58.99**

F MFA Decisions Module (Mark II)

This board is used to establish the ideas of inputs and outputs, high and low 'logic' levels, and how decisions are based on a set of conditions. The board carries four input devices: a slide switch, a push switch, a thermistor and a light sensor plus a socket for an external sensor. Outputs are a buzzer, an on/off relay and a bulb.

The central section of the board provides a NOT gate (inverter), an AND gate and an OR gate. All inputs and outputs are via 2mm sockets, with on-board LEDs to display the state of signals.

F4H27593 each **£79.99**

G MFA Music Module

Number patterns stored in Memory Module can be used to play simple tunes on the Music Module. The 4-bit binary number passed to it is decoded by the on-board circuitry to produce fifteen different notes from the small loudspeaker.

F4H29541 each **£19.99**

MFA Publications USB Set

MFA is a simple but powerful introduction to microelectronics. With emphasis on practical problem-solving, it will challenge your students to use the building blocks of electronics: input-process-output.

Contains a comprehensive set of PDF publications designed to introduce the concepts of electronics decision making, using inputs to control output, electronic counting, and using memory to store data.

Student support consists of printable workbooks, illustrated resource booklets and assessment materials. Teacher resources include INSET activities and detailed student assessment guides.

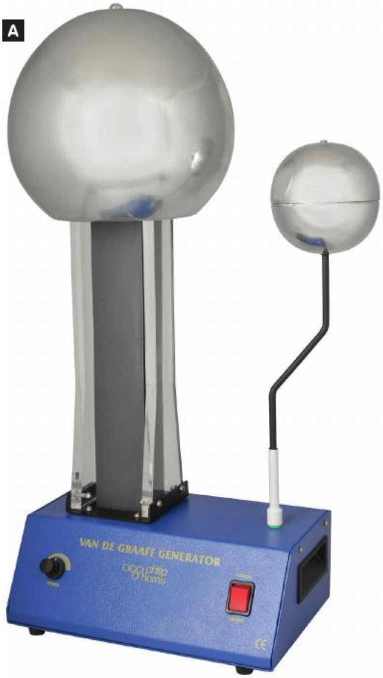
The MFA modules: Decisions, Counting and Memory can be used individually, and become more powerful when used together. The Music and Movement modules extend the activities into playing simple tunes and controlling Lego motors and other simple circuits.

MFA contributes to OCR Additional Applied Science Module 5 Communications, offering activities on: binary codes, flowcharts, logic, block (system) diagrams, the "input-process-output" description of systems, analogue and digital signals. Practical work is frequently related to real-world applications including: medicine, the home, agriculture, sport, manufacture, and music.

Direct Delivery – up to 2 weeks

F4R02586 kit **£29.99**

For students, electricity is one of the most exciting subjects on the syllabus. With the right equipment, you can conduct hands on experiments that will give your class a lesson to remember. We have a wide range of high quality equipment which will bring your classroom alive and stimulate your pupils' learning.

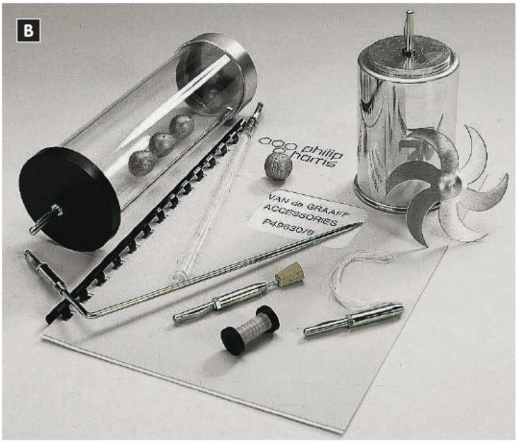


Spares and Accessories

Charge Collecting Belt

Measuring 360mm long, 50mm wide and 1mm thick. Should fit any Philip Harris Van de Graaff Generator from the 1970s or later.

F4H26769 each **£20.99**



A Van de Graaff Generator,

Motor-Driven

An efficient design for all the usual electrostatic experiments and for where a continuous source of high voltage is required. It has a strong metal base with profiled hand grips, housing a quiet running a.c. motor. The discharge sphere may be plugged into the base or supported separately, linked to the arching post with a standard 4mm connecting lead.

- Charge Collecting Belt: silicone rubber having excellent insulation resistance
- Tracking: belt-tracking easily adjusted
- Charge Collecting Combs: aluminium mesh, design to be clearly visible
- Spheres: aluminium, 175mm diameter
- Connections: 4mm sockets in dome and base
- Voltage Developed: up to 200kV, depending on ambient conditions, with a spark length of 60mm
- Discharger: spherical 75mm diameter on rod for plugging into the base earth socket or support in a retort stand
- Supplied with 1.5m mains lead, illuminated mains on/off switch and fuse

Dimensions: 225 x 180 x 480mm.

F4H26758 each **£312.99**

B Set of Accessories

The accessories are provided with 4mm pegs that fit into the top of the sphere.
The set comprises

- Perspex cylinder with metal caps and 4 metallised spheres
- Faraday's Pail
- Head of hair
- Point discharger
- Neon bulb
- Electric whirl
- Hair Comb

F4H26746 set **£63.99**

C Wimshurst Machine

Two transparent plates are supported in two rigid uprights and driven by belt in opposite direction. They are heavy, high resistance plastic with sectors of aluminium sheet. Two leyden jars (condensers) made from corning glass and aluminium foil. The whole is mounted on moulded ABS base.

F4A48215 each **£119.99**

A Malvern Electrostatics Kit

Ideal for small group experiments in electrostatics. The set is built around the dual-purpose electroscope which, while being suitable for general work also enables comparative measurements to be made on the activity of weak radioactive materials. The electroscope has an internal transparent scale divided 0 to 90° (x 10°). Removable glass panels are provided at the front and back, one clear and one ground. A removable insulation bush is fitted into the top of the case, which supports the plated metal blade to which the gold leaf may be attached, and a 4mm socket earthing terminal is fitted at the side of the case. Two interchangeable electrodes are supplied - a 50mm disc on a peg and an elongated hook 160mm long, which may be removed after charging by using an insulating rod. Isolating the gold leaf mount reduces its capacity and increases the sensitivity of the electroscope for radioactivity experiments. The kit comprises:

- 1 Electroscope as described with top plate and hook for electrode
- 1 Packet of gold leaves and detailed instructions for fixing
- 4 Metallised polystyrene spheres 16mm diameter
- 1 Reel of very fine nylon thread
- 1 Stirrup
- 2 Polythene plates 75mm square
- 1 Electrophorus plate 50mm diameter with an insulating handle
- 1 Proof plane, a 13mm diameter metal disc on an insulating handle
- 2 Aluminium cylinders 50 x 25mm diameter
- 1 Polycarbonate strip 250 x 25mm
- 1 Polythene strip 250 x 25mm
- 1 Cotton rubber

F4H26655 kit **£79.99**

B Van de Graaff Generator

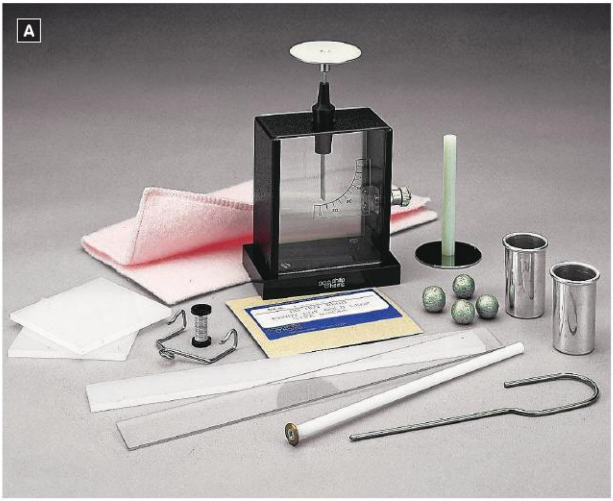
Hand driven. Overall dimensions: 350 x 190 x 480mm. Supplied complete with instructions without accessories.

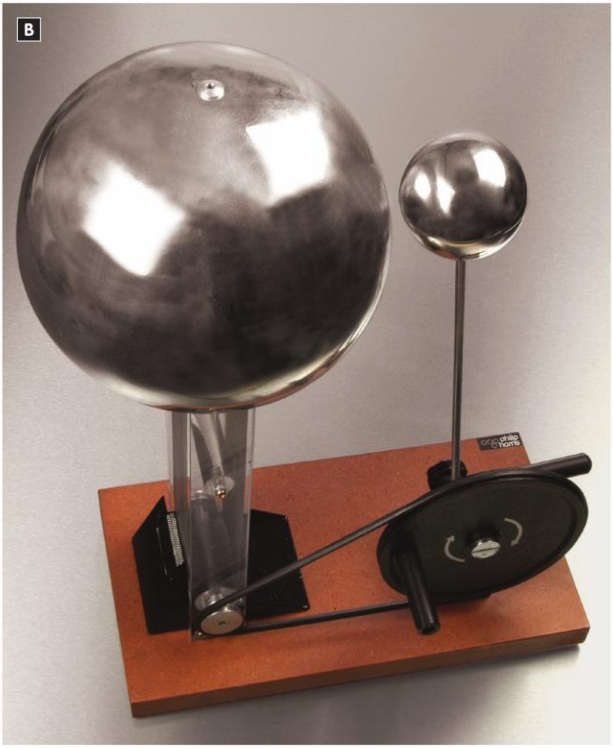
F4H26710 each **£99.99**

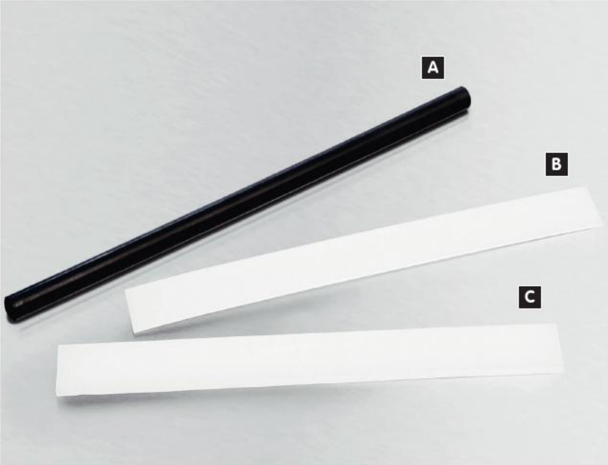
C 'Pith Ball' Electroscope

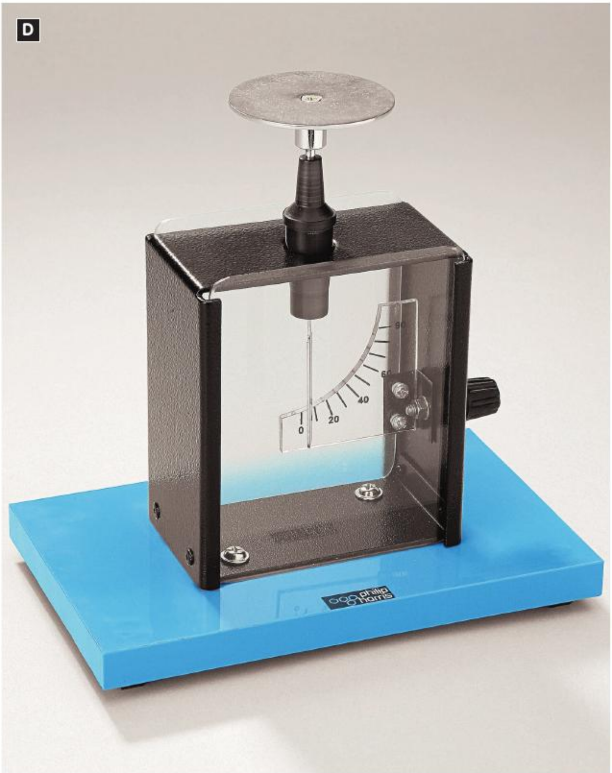
Comprises a pair of pith balls, 16mm diameter suspended by cotton threads from a wire frame stand. Overall height: 160mm approx.

F4H26667 each **£11.99**









Electro-Positive and Electro Negative Materials

The charge produced on a material depends on the nature of the material and also the nature of the material with which it is rubbed. By testing a number of materials after rubbing them together in pairs, a list of relative charges can be drawn up.

Positive Charge ↑

Perspex
Cellulose Acetate
Glass
Silk
Wood
Sulphur
Flannel
Duster
Cotton
Vulcanite (Ebonite)
India Rubber
Polythene
Resin
Gutta-Percha
Metals

Negative Charge ↓

It will be seen that wood becomes negatively charged when rubbed with silk, but acquires a positive charge when rubbed with cotton. Similarly a rod of vulcanite acquires a negative charge when rubbed with silk or flannel, but may be charged positively by rubbing it with India Rubber.

NOTE: The above series should be used as a guide only. Experience shows that erratic results are often obtained, especially when the two materials are close together in the series.

A Ebonite Rod

Dimensions: 300 x 13mm length x diameter.

F4A47958 each **£1.88**

Perspex Rod

Polished finish. 300 x 13mm diameter

F4A47969 each **£3.50**

B Polycarbonate Strips

For producing electrostatics charge by friction. Dimensions: 250 x 25mm.

F4L01491 each **£1.50**

C Polythene Strip, Low Density

For producing electrostatic charges by friction. Size: 250 x 25 x 4.5mm.

F4H26631 each **£1.99**

D Dual Purpose Electroscope With Scale

In this instrument a metal plate, to which a single gold leaf may be attached, is supported by an insulating bush in a glazed metal case provided with a 4mm socket earthing terminal. The front window is clear and the rear window is of ground glass.
An internal transparent scale divided 0 to 90° x 10° is provided for measuring the deflection of the leaf. Two interchangeable electrodes a disc top plate of 50mm diameter and a metal hook 160mm (are supplied) Dimensions: 112 x 63 x 143mm high.
A supply of gold leaves cut to size with detailed instructions for fixing are supplied with each electroscope.

F4H26679 each **£22.00**

A

A Digital Coulombmeter

This unit is a quantitative alternative to the gold-leaf electroscope with internal capacitance 1μF, and max. p.d. between terminals of 100V. It can be charged by contact or by induction by bringing a charged body up to the 25mm collecting plate. The 3½ digit display shows charge in the range of -1999 to +1999nC. A reset button discharges the unit as required. Ideal for use with the 4.2kV Battery Top EHT Unit F4H28305. Two 4mm terminals on the top are used for connection to ground and to the charging body.

Mass: 0.25kg

Size: 95 x 90 x 50mm

Powered by an internal PP3 battery (not supplied)

F4H27799 each **£58.40**

B Battery Top EHT Power Supply

- Powered by a PJ996 battery
- Provides a stepped EHT output from 0-4200V (±2100V) in 700V steps via 4mm sockets
- Output current limited to 140μA
- Power warning LED

Designed for safe use, this unit allows quantitative electrostatics experiments to be performed by responsible students.

Any of the stepped outputs can be connected to the top terminal via a 4mm lead, and any of the other outputs grounded so that the other six sockets are either positive or negative with respect to this. A sphere or collecting plate can be placed on the top terminal. Spooning charge is one example of an experiment that can be carried out with this unit.

F4H28305 each **£114.99**

FREE NEXT DAY DELIVERY
for stocked items
Conditions apply - see the front of the catalogue for details

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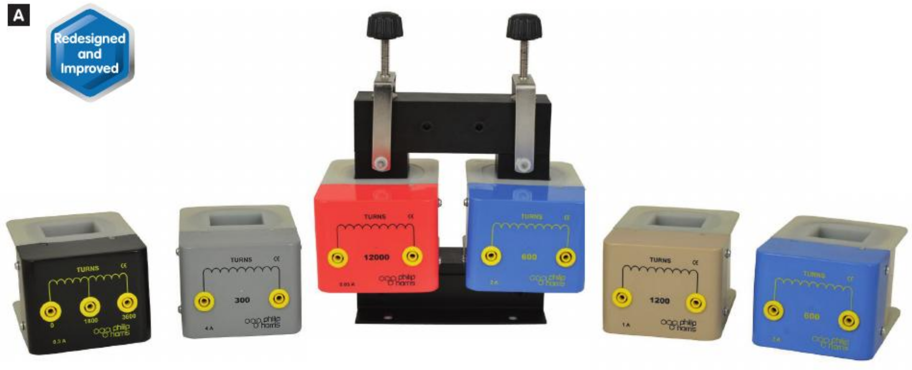

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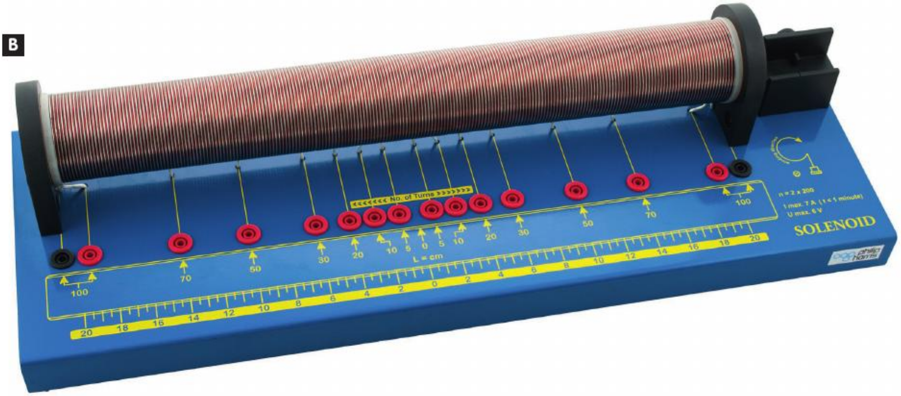


A Dissectible Transformer

This apparatus has been designed primarily for demonstration of the basic principles of the a.c. transformer. The various coils and cores will also serve as the basis of many experiments in electromagnetism, using either direct or alternating current.

Contents:

- 1 clamp base
- 1 1200-turn 1A coil
- 1 laminated armature 150 x 40 x 40 mm
- 1 3600-turn 0.3A coil, centre tapped
- 1 300-turn 4A coil
- 1 12000-turn 0.05A coil
- 2 600-turn 2A coils
- 1 laminated 'U' core, length of side 95 mm, Base 150 x 40 x 40 mm

In the basic transformer set all coils are fitted with 4mm socket connections, but 800 turn coils are available (as accessories) fitted with a captive mains lead. All coils are of enamelled copper wire wound round on high impact plastic moulded bobbins 75mm long with cheeks 75 x 60mm. The robust clamping base is provided with a tommy-bar screw to hold the 'U' core, and two knurled nuts secure the armature and provide for easy changeover of the coils. Soft iron pieces locate on top of the 'U' core arms.

F4H26564 each **£266.99**

B Solenoid Superior

This large solenoid offers a range of experiments in the topics of magnetic fields and the transformer effect. Used with a variable d.c. supply and a Magnetic Flux Density meter the field can be measured at various positions inside and outside the coil, for a range of currents.

The Solenoid's main coil is of 200 turns, wound on a 50mm diameter tube. The overall length of the windings is 420mm. A second coil is wound on the same tube, with the same overall length. This coil is tapped at 5, 10, 20, 30, 50, 70 and 100 turns on either side of the centre, effectively offering a range of coils from 5 turns to 200 turns. The relationship between flux density, number of turns, current, and length of coil can be fully investigated.

4mm sockets are colour coded to encourage correct connection: black sockets - main 200 turn coil; red sockets – second coil 200 turns; blue sockets – tappings on the second coil.

Used with a variable a.c. supply and suitable a.c. meters (Easy Read meter and 20V a.c. Attachment) students can investigate the behaviour of a crude transformer with and without a core. The two coils are used as primary and secondary windings in various turns ratios. The efficiency is very low. Steel laboratory retort stand rods can be used singly or in small numbers to provide a core for the transformer, to illustrate increasing efficiency.

This introductory work can lead into investigation of practical transformers, e.g. C-cores and Transformer Coils where the complete magnetic path provides much higher efficiency. Students can also extend their study using the Dissectible Transformer and its accessories, where they can investigate applications of transformer principles to Induction and Motors.

The "Notes For Use" includes introductory work, with suggestions for extensions.

Maximum voltage: 6V a.c. or d.c.

Maximum current: 7A a.c. or d.c.

Coils: 200 turns 19swg copper wire + 200 turns 19swg tapped

Size: 550 x 155 x 120mm Mass: 1.75kg

F4R03099 each **£93.99**

A Double 'C'-core and Clip

As used in the 'Westminster' Electromagnetic Kit and with coils. Each core is laminated from low loss iron strip to form a roughly rectangular core 90 x 50 x 22mm approximately, with a cross section of 22 x 12mm, and is cut across the middle to produce two equal C's. A strong spring steel clip is provided to hold the two halves together.

Direct Delivery – up to 10 days

F4H76592 set **£29.99**

B Transformer Coils

Silicon steel C-core and clip with a range of coils for use as inductors and transformers. The current ratings are based on 150A per square cm. The coils will run hot, but will not be damaged by short-term currents of up to twice the stated value.

Turns	Air-core	With C-core	Wire Used Rating	Max. Current
60	85μH	10mH	1.22mm	1.81A
60+60	350μH	15mH	1.22mm	1.81A
120	350μH	10mH	0.91mm	1.02A
120+120	1.5mH	60mH	0.91mm	1.02A
1100	20mH	1.0H	0.71mm	0.62A

F4H26436	60 + 60 Turns	each **£31.99**
F4H26459	500 + 125 Turns	each **£29.99**
F4H26473	120 + 120 Turns	each **£29.99**
F4H26461	1200 + 1200 Turns	each **£32.99**
F4H26448	5000 + 250 Turns	each **£29.99**

C Induction Accessories Set

Comprises a six turn copper coil to show the production of a heavy current at low voltage by the melting of a nail, a solder trough to demonstrate the principle of the induction furnace and a set of aluminium rings to show 'Thomson's rings' effect. Two rings are 'solid', the third split to show that the rings must be continuous for 'levitation' to take place.

F4H26606 set **£94.99**

D Motor Accessory Set

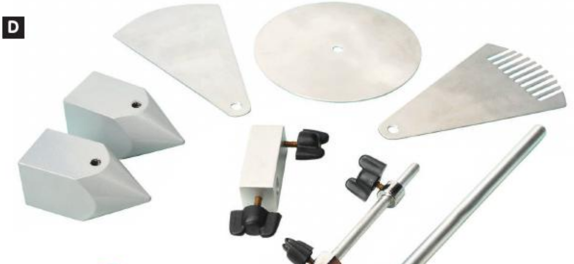
Lenz's law transformer accessory kit to demonstrate the production of large magnetic fields and lenz's law damping on pendulums with and without slits.

F4H26618 set **£31.50**

E Axial and Lateral Search Coil

The Search Coil consists of 5000 turns of very fine copper wire on a bobbin fixed at one end of fibreglass board (Electrically insulated and non magnetic) and on the other end two 4 mm socket terminals are fitted. It can be used to determine field strengths or flux density inside the air gap of magnets or solenoids. A DC or AC signal can be applied to the search coils to study the effect of interacting magnetic fields. The Axial coil has the coil mounted with its axis parallel to the axis of the PCB board. The Lateral coil has the coil mounted with its axis at 90 degrees to the axis of the PCB board.

F4R06034 each **£34.99**



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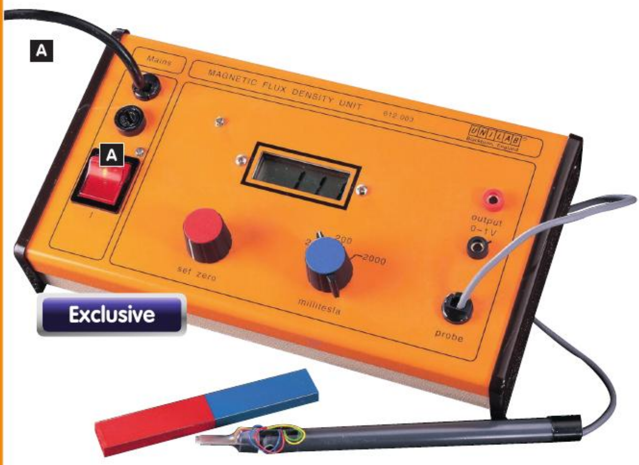


A Digital Magnetic Flux Density Unit

- Direct measurement of magnetic field strengths
- Detects and measures the Earth's magnetic field
- Factory calibrated Hall-effect probe
- 0-1V output for connection to data-loggers

This unit measures magnetic field strengths directly up to 2000mT (millitesla). Using a Hall-effect probe mounted on a rotatable ball and socket head, the Digital Magnetic Flux Density Meter can be used to investigate the fields around magnets and coils quantitatively and immediately.

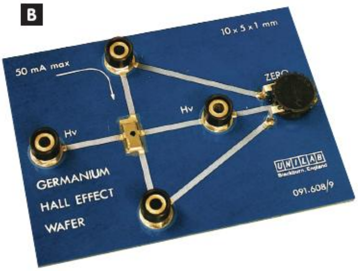
The probe is permanently attached and is factory calibrated to the meter unit. The unit has 3 ranges 0-19.99, 0-199.9, and 0-1999mT selected by a 3 position switch. The LCD has 12mm digits, suitable for demonstration to small groups.

The multi-turn set-zero control can be used to compensate for unwanted background field. On the most sensitive range, the Earth's magnetic field can be measured. As well as displaying the measured field strength on the LCD, a 0-1V output, proportional to the reading, is available at 4mm sockets for connection to a data-logger voltage sensor. Mass: 1.5kg Size: 240 x 135 x 65mm.

Power by mains, with 250mA antisurge fuse.

F4H28729	each **£234.99**

B



B Hall Effect Experiment

The semi-conductor germanium, with its high carrier mobility, makes it possible to demonstrate the Hall effect with very simple equipment. The wafer on this board measures 10 x 5 x 1mm and is mounted on a printed circuit panel which allows a magnet to be brought near the wafer surface. A 10kΩ zero balance control is fitted. Two SP2 cells are needed to provide the circulating current and the bar magnet will then produce a Hall voltage which can be read directly on a millivoltmeter. All sockets are 4mm. Nuffield specification 1012. Mass: 0.3kg Size: 110 x 50 x 23mm.

F4H28469	P-Type	each **£199.99**

Hall Effect Experiment

F4H28389	N-Type	each **£199.99**

C

C Neodymium Magnets

Size for size the most powerful magnets to be developed. May be used for many magnetic demonstrations where intense field strength is an important criterion. For example, if a neodymium magnet is dropped down a length of copper plumbing pipe, the eddy currents generated in the copper by the passage of the magnet create a retarding field great enough to noticeably increase the time of fall of the magnet. These face-polarised disc shaped magnets are available in two sizes as follows:

F4A47132	10 x 8mm	each **£2.99**
F4A47144	20 x 10mm	each **£5.50**

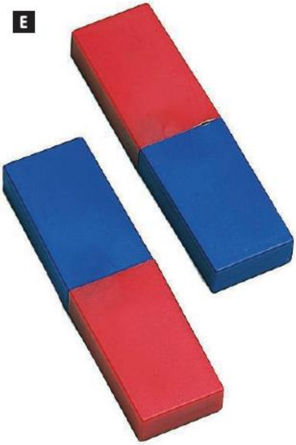
D

D Alcomax Horseshoe Magnets

These magnets in 'Alcomax' have twelve times the magnetic energy of tungsten steel. Pole gap: 23mm. Height: 30mm. Section: 11 x 30mm.

F4A47077	each **£14.99**

E



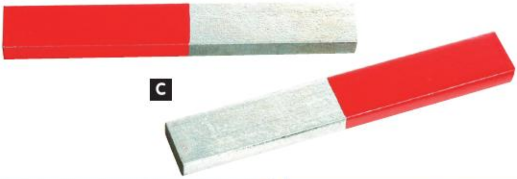
E Bar Magnets, Plastic Coated Ceramic

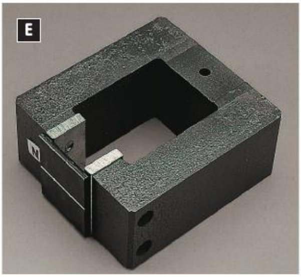
Particularly suited to younger pupils.

They possess good magnetic strength with very high resistance to demagnetisation, whilst retaining a 'traditional' bar magnet appearance by virtue of the red and blue (for N and S) tough plastic casing.

Dimensions: 80 x 22 x 10mm.

F4A46929	pack 2 **£3.90**





A Magnet Kit

A comprehensive kit of magnets and accessories in a compartmented storage case.
Dimensions of case: 320 x 220 x 50mm.

F4A47119 kit **£36.99**

B Magnetic School Resource Kit

An extensive school resource kit.
Includes:

- Set of 12 metal strips and set of 8 metal discs stamped with the name of the metal
- Alnico cast magnets and button magnets, 12, 19 and 24mm
- Set of 10 plotting compasses, 16mm diameter
- Set of 6 marker magnets, 35mm diameter
- Set of 2 ALX III rod magnets, 24 x 8mm diameter
- Set of 2 ALX III bar magnets, 38 x 6 x 6mm
- Set of 5 floating magnets, 24mm diameter
- Packet of coloured magnetic rubber sheets, four colours, 150 x 50mm
- Set of 10 feroba magnets, 50 x 19 x 5mm
- Drum of iron filings, 250g electro magnet
- Pair of steel bar magnets, 75mm
- Pair of alni bar magnets, 75mm, Pair of plastic cased magnets, 8cm
- Pair of alnico bar magnets, 50 x 15 x 10mm
- Piece of lodestone
- Horseshoe magnet set 75, 100 and 125mm in wallet
- Set of 5 Floating magnets on a base
- 4 pieces of soft iron rod, 155 x 19.5mm diameter

F4E46567 kit **£184.99**

C Rectangular Section Magnets, 6% Chrome Steel

In pairs, with keepers.

F4A46875	75mm	pair **£3.99**
F4A46887	100mm	pair **£4.99**

D Magnadur Magnets

50 x 19 x 6mm, as used in 'Westminster' Electromagnetic Kit.

F4A47156	each **£0.42**
F4R05157	pack 10 **£4.00**

E Alcomax Major Magnet

The 'major' magnet in 'Alcomax'; is one of the most powerful permanent magnets ever produced and can be adapted to many uses in education, research and industry, such as field plotting, demonstrating moving coil galvanometers, eddy current damping, testing materials for diamagnetism and paramagnetism, magnetic blowouts and especially for the magnetisation of other permanent magnets. Ideal for flux density measurement, magnetising other magnets, demonstration of the moving coil galvanometer and the deflection of beams and particles. Height 110mm. Width and thickness: 103 x 50mm. Distance between poles: 27mm. Field strength: approx. 0.2 tesla.

F4A47090 each **£264.99**

F Ferrofluid, 10mL

The amazing Ferrofluid is a truly magnetic liquid that consists of micron size magnetic particles (magnetite) in a mineral oil. Particles are coated in a surfactant which prevents them clumping together.

When a magnet is in close proximity the magnetic particles in the Ferrofluid take up the shape of the magnetic field – a 3D version of the classic iron filings on a piece of paper experiment.

The apparent density of ferrofluid can be changed by applying a magnetic field, e.g. place a one pence piece in a shallow dish (5mm) of ferrofluid and it will sink. Bring a powerful magnet underneath and the coin will float!

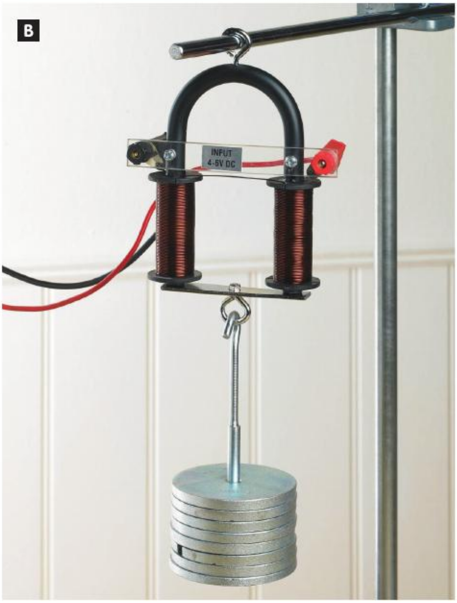
Supplied in a plastic jar containing 10mL of Ferrofluid. A rare earth magnet is also supplied.

F4R05624 each **£10.10**

G Iron Filings in Sprinkler Pot

Iron filings pre-packed in cardboard 'sprinkler pots'. Contents of pot: 225g.

F4A47351 pot **£1.85**



A Eddy Current Kit

For providing a qualitative practical demonstration of Lenz's law. Comprising a copper tube 320 x 15mm (l x d) together with a pair of cylindrical 'plugs'. The plugs are identical in appearance and mass but one is plain steel and one is a powerful neodymium magnet. The time taken to fall is greatly extended as a result of the eddy currents induced in the copper generating a magnetic field which opposes the movement of the magnet. Supplied with a pair of plastic caps to provide self contained storage.

F4F64953 each **£11.20**

B Electromagnet

Made from 9mm mild steel rod, with overall dimensions of 110 x 60mm. It is wound with 1.6mm enamelled copper wire on plastic bobbins, with small terminal block connectors. An armature is provided. With a current of 5A, a force of 20N is required to separate the armature from the electromagnet. Maximum recommended current is 8A.

F4H26321 each **£8.15**

C Apparatus to Show Force on a Conductor in a Magnetic Field

Comprising a strong U-shaped magnet and a pair of brass rails with 4mm socket terminals. A brass axle with plastic discs is free to roll along the rails and completes the electrical contact between them. When the axle is placed on the rails between the poles of the magnet, and a power supply unit is connected, the axle is repelled and rolls along the rails away from the centre of the magnetic field.
Dimensions: 175 x 60 x 58mm high.

F4H26629 each **£129.99**

D Magnetising and Demagnetising Coil

Low voltage, suitable for magnetising and demagnetising ordinary magnets, iron bars, strips, etc. Comprises a solenoid wound with insulated copper wire and mounted on a base complete with switch and 4mm terminals.

- Solenoid 250mm long x 35mm internal diameter
- Operating voltage 12V a.c. or d.c. at 6A
- Magnetising by a.c. or d.c.
- Demagnetising by a.c. only

F4H26319 each **£59.99**

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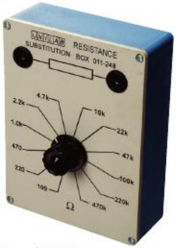

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L

A Easy-Read Meter

Use the meter to measure the current through the Helmholtz Coils. The attachments are colour-coded and their sockets are arranged to help students grasp the concepts of shunts and multipliers. The basic unit has an input impedance of 100kΩ. The resolution is 0.01 and the accuracy is ±2%. Supplied with a PP3 battery that gives a useful life of over 1000 hours, the Easy-Read displays 'LO BAT' when the battery needs to be replaced.

Mass: 0.25kg, Size: 95 x 90 x 55mm.

F4H79933 each **£49.99**

Easy-Read Attachments

The black shunts adapt the Easy-Read for current measurement and their sockets are found in the ends of the attachment (current passes through). The orange multipliers adapt the Easy-Read for voltage measurements, and have their sockets on the front of the attachment (voltage is measured across a circuit component). The 20V d.c. attachment has an input impedance of 10MΩ.

At least one of the following attachments should be bought for each Easy-Read meter.

B	**F4H30919**	20V d.c. Attachment	each **£14.99**
C	**F4H30671**	20V a.c. Attachment	each **£18.99**
D	**F4H31067**	1A/10A a.c. Attachment	each **£63.99**
E	**F4H31158**	20mA d.c. Attachment	each **£19.99**
F	**F4H30737**	10A d.c. Attachment	each **£14.50**

G Decade Capacitance Box

This unit incorporates a high-grade 10-position switch which selects capacitance in the range 10 x 1µF (1µF to 10µF).

F4H27313 each **£49.99**

H Capacitance Substitution Box

The Capacitance substitution box is housed in a 90 x 90 x 35mm grey plastic case with 4mm sockets. The 12-position switch selects the following values: 220, 470pF; 2.2, 4.7, 10, 22, 47, 100, 220, 470nF; 1µF.

Maximum working voltage 250V d.c. 'Make before break' switch.

F4H27283 each **£29.99**

I 1K Potentiometer

A convenient box with 2 mounted potentiometers for various electrical experiments, 4mm safety sockets are provided. Range : 0-10K ohms, 1W + 5% continuously variable 0-470K ohms, 1W + 5% continuously variable. Range : 0-10K ohms, 1W + 5% continuously variable 0-470K ohms, 1W + 5% continuously variable.

F4R05958 each **£15.75**

J Resistance Substitution Box

Switch Selectable values 470kΩ, 220kΩ, 100kΩ, 47kΩ, 22kΩ, 10kΩ, 4.7kΩ, 2.2kΩ, 1kΩ (all watt 5%); 470Ω, 220Ω, and 100Ω (1 watt 5%); 'Make before break' switch.

F4H27234 each **£16.99**

K Resistance Unit

A range of resistance units based on a high stability metal film element. They offer improved accuracy and robustness, and are less expensive than traditional resistance coils. Accuracy 1%.

F4H30865	1.6V, 5 Ohm	each **£11.99**
F4H31122	2.2V, 10 Ohm	each **£4.99**
F4H30725	3.0V, 20 Ohm	each **£7.99**

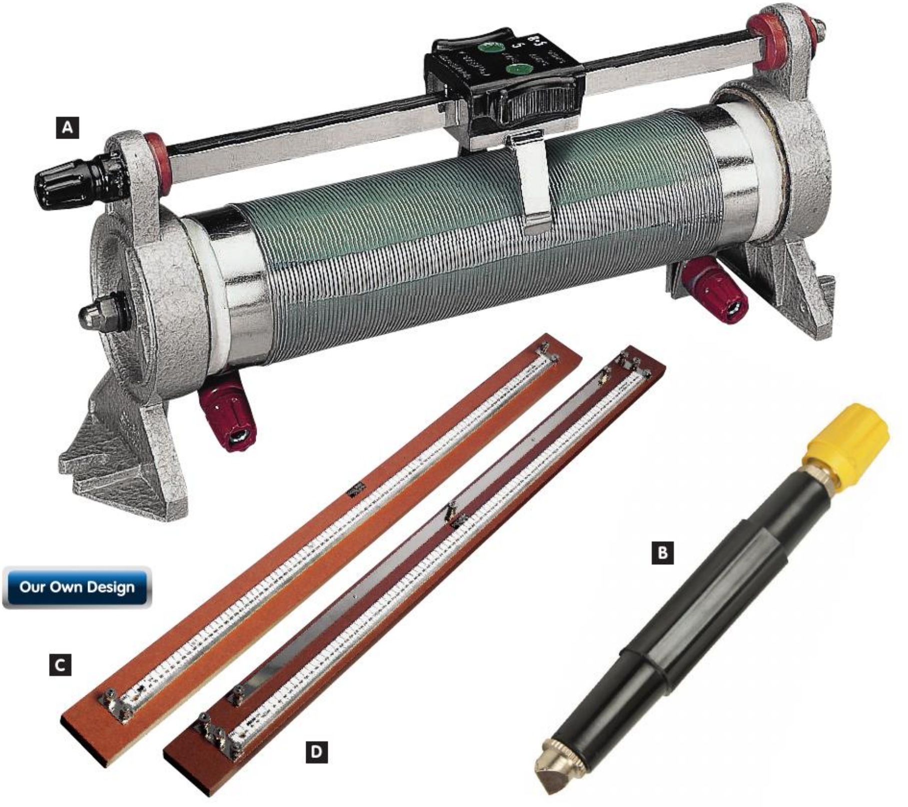
L Unilab Reed Relay

Nuffield specification 1010. A single-pole change over reed relay capable of up to 400 changeovers per second when driven by a Power Signal Generator, in repeated charge and discharge of parallel-plate capacitors. Maximum contact ratings: 12V, 100µA, 100µF.

Coil operating voltage approximately 5V r.m.s., d.c. to 400 Hz. A diode in series with the coil ensures only one changeover in every cycle.

Size: 90 x 90mm.

F4R01326 each **£47.99**



A Rheostat, Standard and Extended Ranges

Rheostat, Standard Range

A comprehensive range of rheostats offering excellent value for money. They are wound with heavily oxidised resistance wire on a vitreous enamelled steel tube with the winding secured in place with a ceramic cement. The tube is supported on robust diecast end stands and the heavy duty sliding contact is of the multi-leaf phosphor bronze type, nickel-plated for corrosion resistance. 4mm terminal posts are fitted, facilitating external connection by conventional 4mm plug leads, spade terminals or bare-ended leads.

	Resistance Ω	Max current A	Tube size mm	Overall size mm	each
F4A49086	135	1.4	200 x 43	250 x 100 x 65	**£28.50**
F4A49098	55	2.3	200 x 43	255 x 100 x 65	**£31.70**
F4A49104	16	4	200 x 43	255 x 100 x 63	**£31.70**
F4A49116	8.5	5	200 x 43	255 x 100 x 63	**£29.30**
F4A49165	37	3.2	300 x 43	355 x 100 x 63	**£29.80**

Rheostat, Extended Range

An extended range of rheostats differing in resistance and dimensions from the standard range but in other respects having the same specification.

	Resistance Ω	Max current A	Tube size mm	Overall size mm	each
F4H04969	1200	0.3	200 x 38	255 x 52 x 92	**£33.50**
F4H04994	50	4	200 x 38	255 x 52 x 92	**£31.70**
F4H05044	25	5	400 x 68	465 x 90 x 153	**£66.50**

B Jockey

For Wheatstone bridge and potentiometer work, with moulded ribbed insulating handle, plated-brass contact with locating notch, and a plated-brass terminal with a 4mm socket. Dimensions: 95 x 15mm diameter.

F4H27099 each **£5.90**

C Potentiometer, 1m, Single Wire

Comprising a 0.56mm constantan wire stretched along a metre scale subdivided into millimetres and centimetres, clamped to stout, plated brass end plates.

The clamping system is designed to make good electrical contact with the wire at the exact ends of the scale thus leaving virtually no margin for 'end errors'. The terminating strips are provided with heavy duty 4mm socket terminals and the whole is mounted on a stackable polished hardwood baseboard.

Supplied WITHOUT jockey.

Dimensions: 1.13m x 81mm x 50mm.

F4H27088 each **£34.99**

D Wheatstone Bridge

Comprising a 0.56mm constantan wire stretched along a metre scale, subdivided in centimetres and millimetres, clamped to stout plated brass terminating plates designed to ensure that the connections are made exactly at the ends of the scale. A heavy plated brass strip with 4mm socket terminals is fastened along the back of the baseboard and provides a two-gap system for normal Wheatstone bridge work.

Supplied WITHOUT jockey.

Dimensions: 1.08m x 81mm x 50mm.

F4H27076 each **£36.20**

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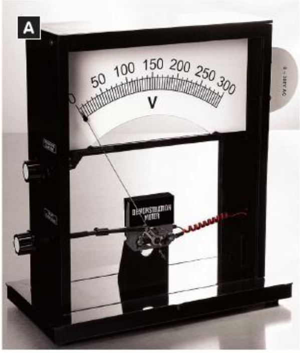

Code	Dial Range	Input	Price
F4L15969	2.5-0-2.5mA	d.c. Current	each **£13.30**
F4L15970	0-10mA	d.c. Current	each **£13.30**
F4L15982	0-100mA	d.c. Current	each **£13.30**
F4L15994	0-1A	d.c. Current	each **£13.30**
F4L16007	0-10A	d.c. Current	each **£13.30**
F4L16019	0-1V	d.c. Voltage	each **£13.30**
F4L16020	0-15V	d.c. Voltage	each **£13.30**
F4L16032	5-0-5V	d.c. Voltage	each **£13.30**
F4L16044	0-10mA	a.c. Current	each **£13.30**
F4L16056	0-1A	a.c. Current	each **£13.30**
F4L16068	0-10A	a.c. Current	each **£13.50**
F4L16079	0-15V	a.c. Voltage	each **£13.30**
F4L16081	0-300V	a.c. Voltage	each **£13.30**

B

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A Interscale Demonstration Meter

- Versatile meter that can show A.C. or D.C.
- Highly sensitive moving coil galvanometer
- Scale on both sides of the dial for class demonstration
- Easy observation of working parts

A versatile demonstration meter that can be converted from a Voltmeter to an Ammeter on either A.C. or D.C. by the use of interchangeable dials (sold separately). Each dial fits through a slot in the side of the case and connects through four fixed 4mm sockets. The meter operates using a moving coil galvanometer housed within a plastic case allowing all working/moving parts to be observed through either side of the meter. Scales are marked on both sides making this unit ideal for class demonstration. Dimensions: W300 x H310 x D150mm.

F4L16093 each **£62.99**

B Digital Multimeter

A professional instrument offering the normal multimeter functions and the ability to measure capacitance and frequency over a wide range with a high level of accuracy.

- Display: 3 3/4 digit LCD with 15mm characters and ancillary 40 segment bar graph. Full complement of display annunciators
- d.c. volts: 600mV, 6V, 60V, 600V, 1000V
- d.c. current 600mA, 10A
- a.c. volts: 600mV, 6V, 60V, 600V and 750V r.m.s: 50 to 600Hz
- a.c. current: 600mA, 10A r.m.s., 50 to 600Hz
- Resistance: 600Ω, 6kΩ, 60kΩ, 600kΩ, 6MΩ 60MΩ
- Capacitance: 6nF, 60nF, 600nF, 6μF, 60μF
- Frequency: 100Hz, 1kHz, 10kHz, 100kHz, 600kHz

The above ranges are all full scale readings. Resolution is generally to four significant figures for each range. e.g. 60V would be resolved to 10mV. Frequency range sensitivity is 0.1V r.m.s. up to 100kHz. 0.5V r.m.s. above 100kHz.

- Audible continuity: Sounds if resistance being measured is less than 40Ω
- Input resistance: 10MΩ
- Accuracy typically: ±0.8% at 23°C ± 5°C and 75% R.H. max
- Overload protection: 1000V d.c., 750V r.m.s. a.c. 0.5A fuse on current ranges. 10A range unfused. Other ranges, 400V d.c. or r.m.s. a.c. Over range indication in display.
- Data handling facilities: Data hold facility - max. limit selection, relative value selection
- Sampling rate: 3 samples per second
- Operating conditions: Temperature range 0 to 40°C (storage -20 to 60°C). Humidity 75% max (storage 80% max)
- Dimensions: 195 x 92 x 43mm
- Mass: 380g (500g in holster). Supplied complete with holster carrying case, test leads/probes, batteries and instruction booklet
- Safety: IEC1010, CAT III, 1000V

F4L20009 each **£117.50**

C Multimeter

Compact 3½ digit LCD digital manual range multimeter, ideal for educational use 20 ranges including transistor test, 10A current test, audible continuity test, diode test, and square wave 50Hz frequency test.

Overload protection on all ranges except 10A DC current range. Low battery indication. Robust ABS housing, with protective yellow rubberised holster.

A low cost multi-function instrument which offers excellent value for educational use.

Supplied complete with safety test leads, battery and instructions.

Designed in accordance with IEC1010 600V Cat II.

F4R06226 each **£13.25**

D PAT Testing Kit

Designed for ease of use, the PAT Testing Kit is a perfect option for those with a small amount of appliances to test. While other PAT testers can be quite complex, the UT527 makes testing easy. Simply connect up your appliance using the included leads, press the test button you need and the tester will either display PASS/FAIL to tell you if the appliance is safe or not.

This tester is suitable for testing both class I and class II appliances as well as power sockets, extension leads and IT equipment. It carries out all PAT procedures required by the IET Code of Practice including insulation resistance, earth continuity and more. Includes: PAT Tester, test lead, alligator clip and batteries.

Features:

- Manual PAT tester - doesn't display full testing results (PASS/FAIL indication only)
- Test class I, class II and cables
- Battery powered
- Lightweight
- One touch testing
- Simple to understand and follow
- Hard transit case
- Performs Earth Continuity, Insulation Resistance and Live / Neutral Checks for o/c, s/c and crossed testing

F4R06101 each **£229.99**

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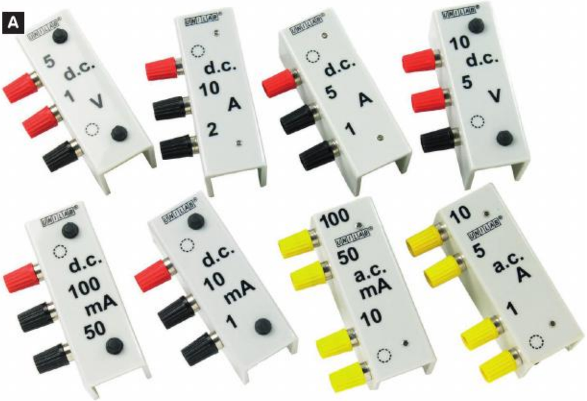

B

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A Shunts for Basic Student and Centre-Zero Meters

A set of shunts and multipliers developed to withstand overloads resulting from common student errors. Tough Shunts cover the ranges of voltage and current commonly required in practical work.

- d.c. Ammeter Attachments: these units consist of suitable resistor networks mounted in a grey component channel fitted with three 4mm terminals as a common positive with two ranges
- d.c. Voltmeter Attachments: similar to the d.c. ammeter attachments described above except that the two resistor networks are arranged to have a common negative terminal
- a.c. Voltmeter and Ammeter Attachments: similar to their d.c. equivalents except that appropriate rectifying or transformer circuits are included designed for 50/60Hz circuits

Code	Dial Range	Input	PRICE
F4H31006	1V/ 5V d.c.	d.c. Multiplier	each **£12.50**
F4H31043	5V/ 10V d.c.	d.c. Multiplier	each **£18.50**
F4H31201	50A/ 100mA d.c.	d.c. Shunt	each **£16.50**
F4H31080	10/50/100mA a.c.	a.c. Shunt	each **£35.50**
F4H30385	2A/ 10A d.c.	d.c. Shunt	each **£13.50**
F4H30427	1A/ 5A d.c.	d.c. Shunt	each **£13.50**

B Centre-Zero Meter

- 1000Ω movement, moving coil, diode protected against overloads up to 12V d.c.

A centre-zero meter, electronically identical to our Basic Student Meter (Item E). This unit is ideal as a galvanometer for investigating electromagnetic induction, or as an indicator in slow a.c. experiments. The movement is arranged as a 50-0-50mV, 50-0-50μA meter with a subsidiary scale marked 3.5-0-3.5 for use with the Dual 3.5mA shunt. Mass: 0.37kg. Size: 150 x 100 x 70mm.

F4H30841 each **£75.50**

C Basic Student Meter

- 1000Ω movement, moving coil, scale length 74mm
- Full scale deflection 20-0-100mV, 20-0-100μA, accuracy ±2% of f.s.d.
- Wide range of shunts and multipliers available
- Large range of a.c. & d.c. currents and voltages may be measured
- Diode protection of the movement is incorporated and overloads of at least 12V d.c. can be tolerated

This meter was originally designed to meet the Nuffield A-level Physics specification 1002. For many years it has set the standard in low-cost analogue meters for education, being flexible and robust in use.

The meter has two scales (2-0-10 and 1-0-5) and adding a shunt or multiplier converts it into a dual or triple range ammeter or voltmeter. Mass: 0.37kg. Size: 150 x 100 x 70mm.

F4H30981 each **£49.99**

D Investigating Resistivity

Low cost apparatus for student investigation into resistance, length and cross-sectional area

Also acts as a bridge or potentiometer.

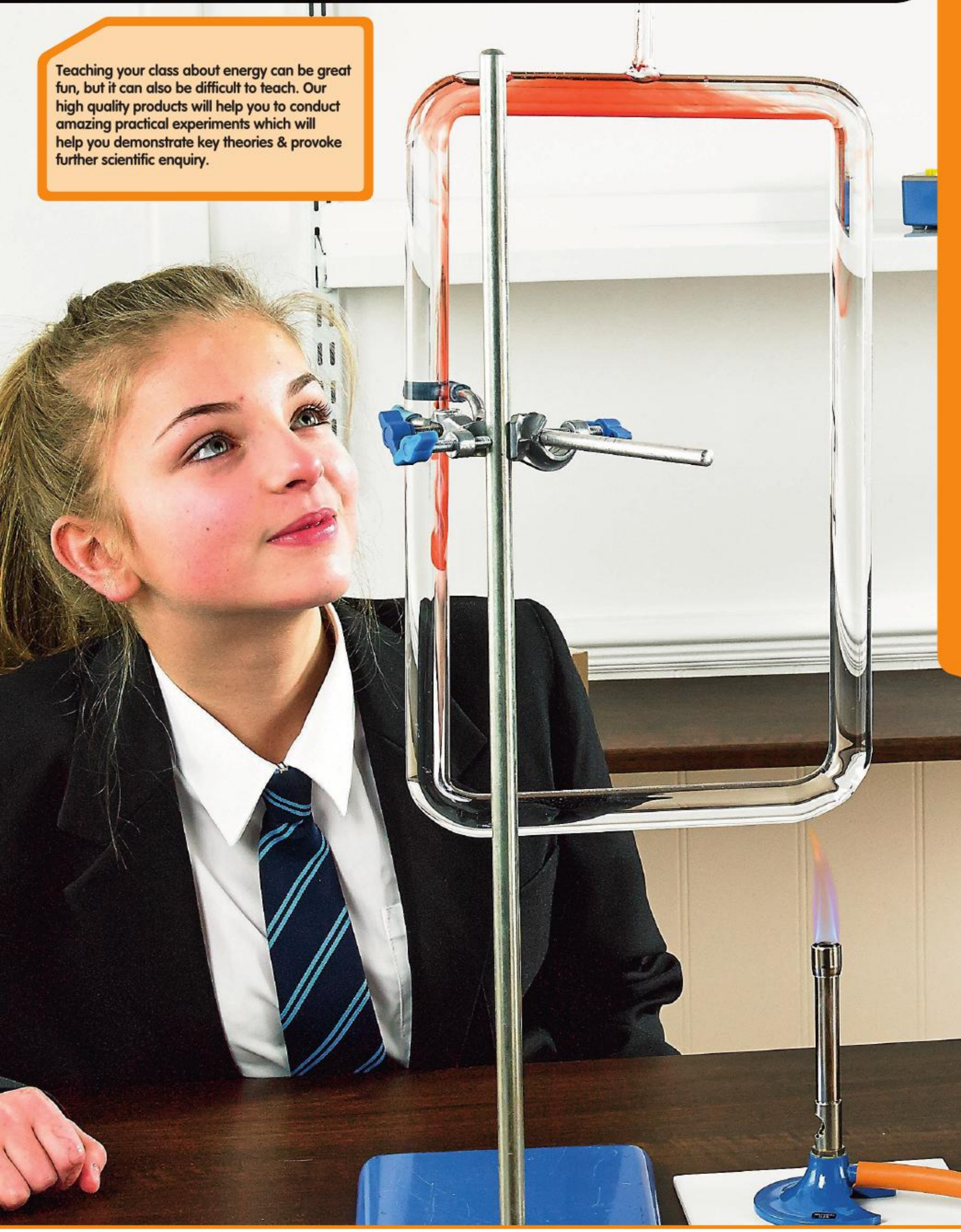
This 40cm Resistance Board is designed to allow students to investigate resistance quantitively. The board is fitted with 4mm terminals connected by a length of resistance wire against a scale, and a "jockey".

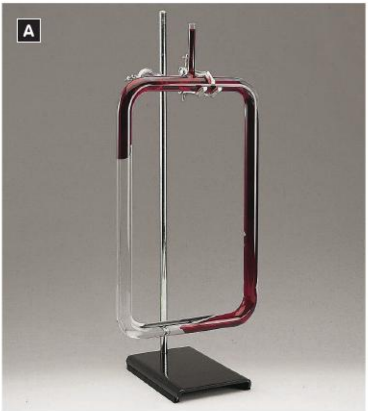
Three different samples of wire with ratios of cross-sectional area 1:2:4 are provided. Experiments into the relationship between resistance and cross-sectional area can easily be conducted. If required other types of material can be connected between the sockets and their resistance investigated.

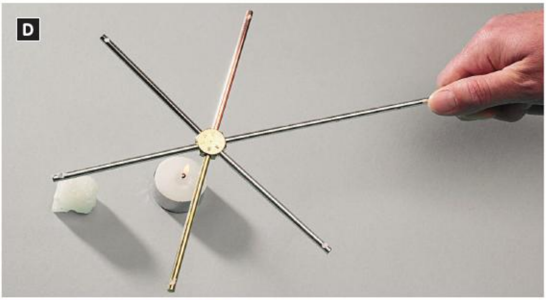
Sockets are provided to enable the board to be used as a 40cm bridge/potentiometer. The Unilab Basic Student Meter fitted with appropriate shunt is ideal for use with this board. Power can be provided by a 1.5V SP2 (R20) battery and or any low voltage power supply (e.g. Lockmaster).

F4H27106 each **£41.99**

Teaching your class about energy can be great fun, but it can also be difficult to teach. Our high quality products will help you to conduct amazing practical experiments which will help you demonstrate key theories & provoke further scientific enquiry.







Helpful Hint

Heat moves in three ways. Give your students direct, hands-on experience to encourage clear understanding.

Convection is the movement of currents in air or water. Warm air is less dense than cold air, so the cold air sinks and the warm air rises. This is how hot air balloons obtain lift.

Conduction: Only metals such as copper and aluminium make good conductors. Heat energy is passed as minute vibrations from atom to atom within the solid. Try it with the Conductivity Star! Does conduction relate to other properties such as density or atomic mass?

Radiation is where energetic particles travel through a vacuum or matter containing media.

Convection and conduction are quite slow. Students can experience radiant heat directly, carefully using the backs of their hands at a distance of a few centimetres, to feel the heat radiated by the different faces of a Leslie's Cube. Like light, radiant heat is blocked instantly by any opaque object.

A Convection in Water Apparatus

Comprising a 360 x 210mm rectangle of 22mm glass tubing. In use the tube is mounted vertically in a retort stand. Convection currents may be generated by gently heating one of the lower corners of the rectangle, and a small amount of potassium manganate(VII) crystals dropped into the tubule will act as an indicator.
Supplied as tube only WITHOUT clamps.

F4A42754 each **£22.99**

B Convection in Air Apparatus

Consists of an enamelled box 230 x 75 x 75mm with a sliding glass front and two detachable glass chimneys measuring 150 x 50mm diameter.
A lit candle is mounted underneath one of the chimneys and the resulting convection current can be observed by using smoke from a smouldering taper. Supplied WITHOUT candles.

F4H25523 each **£32.50**

C Leslie's Cube

Tinplate box with 130mm sides. The vertical faces of the box are blackened, roughened, varnished and polished respectively. The top opening is 75mm diameter and is fitted with a lid. The apparatus is filled with water maintained at boiling point by a low bunsen flame. Infra red sensors may be used to compare the relative radiant heat output from each of the four faces.

F4L26899 each **£33.99**

D Conductivity Star

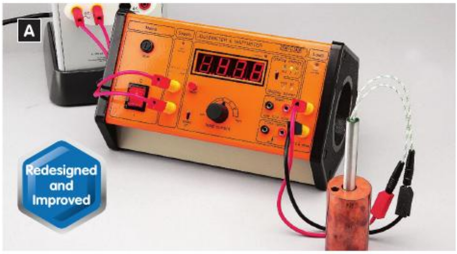
Find out which metal conducts heat best by placing a small amount of wax at the tip of each rod and heating from beneath in the centre.
Pack includes a small block of wax and rods of aluminium, bronze, steel, nickel and copper.

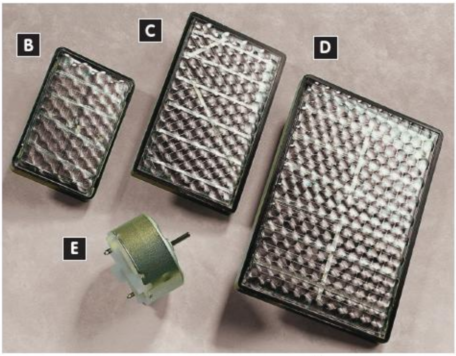
F4G86207 each **£6.50**

E Thermal Conductivity of Metals Apparatus

Comprising bars of copper, iron, aluminium and brass with nominal thermal conductivities of 395, 72, 240 and 128 Wm-1K-1 respectively, each 80 x 20 x 1.5mm, provided with a hollow for wax and mounted on a wooden ring. 130mm outside diameter, 80mm inside diameter.

F4A42730 each **£6.99**





A Joulemeter and Wattmeter

- 4-digit LED display of either energy delivered or power supplied
- 6 switch-selectable ranges, with internal shunts
- Output sockets suitable for connection to dataloggers and external counters

The unit is ideal for accurate measurement of either cumulative electrical energy delivered to a load from a power supply, or instantaneous power. A range of experiments are possible from simple investigations into specific heat capacity to measurement of energy stored in LCR Circuits.

When measuring energy delivered, an audible bleep (which can be switched off) indicates each increment of the least significant digit on the display, and the TTL Pulse (of duration 25 ms) is output via 4mm sockets for external counters. When measuring power, a voltage sensor across the 0-10V 4mm socket power output can be used for data-logging.

An instruction manual of experiments is included.

Display: 4-digit, 20mm high LED display with decimal point automatically moved by the range switch.

Input: 24V d.c. max or 17V rms a.c. max of any wave form d.c. to 10kHz.

Ranges: from 0.1mJ to 100J per count in 6 decades from 0.001mW to 100W (least significant digit) in 6 ranges LEDs indicate readings in mW and kJ.

Power: Mains unit with 1.8m of 3-core cable, illuminated ON/OFF Switch and 1A fuse.

Mass: 2.1kg.

Sizes: 240 x 160 x 160mm.

F4H28986 each **£199.99**

Solar Cells

Output voltage 0.45V in clear sunlight. They may be linked in series/parallel for increased power.

		mA	Dimensions	
B	**F4A43357**	200	55 x 35mm	each **£2.50**
C	**F4A43369**	400	75 x 45mm	each **£9.99**
D	**F4A43370**	800	95 x 65mm	each **£11.50**

E Solar Motor

RF510T, 0.3 to 4.5V (1300 r.p.m. at 1.5V). Axle diameter 2mm. Current consumption 22mA.

F4A43345 each **£1.40**

F Class Joulemeter Mk II

- Energy measurement made simple
- Connects between power supply and load
- LED Indicator gives one flash per 100J
- Calculate specific heat capacity
- Accepts 9 to 16V a.c. or d.c.
- Ideal for use with calorimeter blocks

Although it can drive loads up to 10A, ideally it is best used with loads requiring between 0.4 and 4A when accuracy is ±5%.

F4H28834 Each **£73.99**

G Thermal Conductivity

The thermal conductivity set comprises four metal bars - copper, aluminium, brass and steel - held firmly together in parallel with a plastic rigid carrier. Each bar has a liquid crystal temperature sensitive strip attached and its conductivity value marked on the back of the carrier. The liquid crystal strips have 8 boxes and change to a green colour at about 40°C. The thermochromic liquid crystal used in the conductivity bars shows temperatures in the range 35°C to 45°C. The lowest temperature indication is a coppery red colour at 33°C and the hottest is a blue colour at over 45°C. The 35°C to 45°C appears in green.

F4R03213 each **£32.15**

H Immersion Heater, 12V 50W

A fully sheathed miniature 12V, 50W (nominal) heater specially developed for use with metal block calorimeters. The element is housed in a 150mm stainless steel tube, the heated section occupying 70mm from the closed end. Electrical connection is via 180mm flying leads with heat resisting insulation, sealed into the body tube, terminating in 4mm sockets.

F4A42584 each **£26.75**

Metal Block Calorimeters

For the experimental determination of the specific heat capacity of different metals. Cylindrical metal blocks, mass 1kg adjusted to an accuracy of ±2%. Each block is drilled with 2 holes: a large central hole, 12.5mm diameter for immersion heater and a smaller hole, 7.5mm diameter to suit a thermometer or temperature sensor.

I	**F4H25456**	Copper	each **£24.99**
J	**F4H25444**	Mild Steel	each **£10.50**
K	**F4H25432**	Aluminium	each **£18.50**

L Calorimeters, Copper

With parallel sides and rolled rim.

F4A42456	75 x 50mm	each **£5.99**
F4A42468	100 x 65mm	each **£8.50**

M Calorimeter, Aluminium

With parallel sides and rolled rim.

F4A42481	75 x 50mm	each **£5.60**

N Calorimeter Stirrer

Diameter: 40mm, length: 170mm.

F4R05623 each **£1.60**

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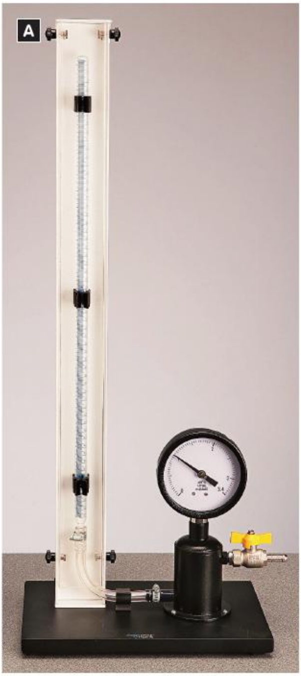


A Boyle's Law Apparatus

Designed for demonstration, the column is clearly visible to the whole class without them having to crowd around the demonstration bench. A wide-bore glass tube is mounted vertically in front of a scale graduated 0 to 65cm^3. Zero corresponds to the inside of the closed (top) end of the tube. Air is confined in the tube by a coloured oil contained in a metal pressure chamber which is fitted with a Bourdon-type gauge calibrated 0 to 3.4 x 105 Pa. As the pressure in the oil chamber is increased oil is forced into the glass tube and the volume of the contained air and its actual (total) pressure are directly indicated.

The tube is of extra strong glass having a very large safety overload margin.

As a further precaution a plastic safety screen is secured over the front.

Supplied complete with oil.

Overall height: 690mm.

F4H25298 each **£127.99**

Light Red Oil

Direct Delivery – up to 6 weeks

F4A41750 250mL each **£10.50**

B Bourdon Gauge

For the measurement of actual (total gaseous) pressure. Circular gauge, overall diameter 106mm, depth 40mm. The dial reads 0 to 3.4 x 105 Pa actual (total) pressure and the case has a clear Perspex back so that the working parts may be seen. A tubule, 8mm diameter, provides connection to the system under investigation. The gauge is mounted on a heavy base 102 x 102 x 25mm, with rubber feet. Overall height: 220mm.

F4L20035 each **£74.99**

C Crushing Can

To show the forces exerted by atmospheric pressure. A light walled tinplate can, H260 x 75mm diameter, with an air-tight neck and screw cap. A small quantity of water in the can is boiled vigorously until steam occupies the space inside the can, at which point the top is screwed down tightly and the heat source removed. As the can cools down, atmospheric pressure is increasingly exerted until the can noisily collapses.

F4A41798 each **£2.40**

D Jolly's Bulb and Gauge

Palm-sized, hollow metallic ball with a manometer connected to it for demonstrating change of pressure in a closed volume of air when heated or cooled. Immersing the ball in a water bath at a specific temperature allows the relationship between pressure and temperature of the enclosed air to be investigated in order to demonstrate the behaviour of an ideal gas. Approx. 85mm diameter hollow ball.

F4L71651 each **£48.99**

E Boyle's Law (Horizontal Mount)

Designed as a smaller, more economical version of the Standard Boyle's Law Apparatus.The apparatus consists of a horizontally mounted acrylic tube with a graduated scale along one side (scale graduated from 0 to 300cm3). The tube unit is sealed by a standard gas tap next to which is mounted a standard pressure gauge. The effective length of the tube is controlled by altering the position of a rubber stopper moved via a screw thread. Users can select the effective length of the tube by positioning the stopper and closing the gas tap. The volume of the tube can be read off the scale and printed against the corresponding pressure taken from the gauge. By varying the position of the stopper Boyle's Law can be investigated. This unit has the advantage of not requiring oil to indicate the volume of air. The tube is made out of acrylic which is known to fail 'safely' if punctured.

F4L71663 each **£94.99**

F Tornado in a Bottle

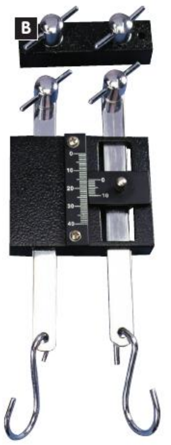
Connect two bottle together one filled with water Turn the joined bottles upside down, swirl the water round and round, then watch what happens. Only a small amount of water flows into the lower bottle because of the reduced pressure above. By swirling the upper bottle in circles, water begins to pour again and a vortex is created. 20 assorted colours included. Size: D32 x H48mm.

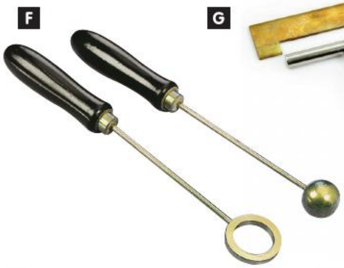
F4R05636 pack 20 **£1.20**

G Small Displacement Vessel

Mild steel with overflow, for specific gravity experiments.

F4L35816	115 x 50mm approx.	each **£5.99**
F4L41282	225 x 125mm approx.	each **£12.75**





A Hero's Engine (Eolipile)

Comprising a borosilicate glass bulb 70mm diameter, with side arms bent at right angles and formed into jets at their tips. The bulb is carried upon a metal stand which leaves it free to rotate about its horizontal axis. If about 25cm³ of water is introduced into the bulb and boiled the issuing steam causes rapid rotation. Supplied complete on stand. Dimensions of base: 180 x 120mm.

F4L32190 each **£36.99**

B Young's Modulus Apparatus

Comprises a scale plate carrying a 0 to 30mm scale, and a moveable vernier readable to 0.1mm. Both have bars with clamping screws for the wires and hooks for the tension weight and loading masses. A ceiling clamp is provided for the upper ends of the wires, together with a pair of large woodscrews for attaching it to a convenient overhead beam, door frame etc. A tension weight, mass 1.3kg approx, for the comparison wire is also included. Supplied WITHOUT load masses or wires.

F4H25213 each **£88.99**

C Hookes Law Apparatus

To demonstrate that the relationship between the extension on a spring is proportional to the load applied to it. The apparatus consists of a high quality, moveable, 120mm scale that is mounted on a simple stand and base.
A combined mass hanger/pointer is provided and is connected to the suspended spring to allow easy reference to the scale. Dimensions: D100mm x H250mm.

Direct Delivery – up to 10 days

F4L23735 each **£53.99**

D Faradays Law

An assembly supports a coil so that it can be easily slide up and down a support tube and locked in position. When a small cylinderical magnet (supplied) is dropped down the tube, the resultant induced EMF can be monitored with an oscillioscope or data-logger. The amplitude varies with speed and this provides the basis for a student investigation into the relationship between distance fallen by the magnet and the output amplitude. At post-16, equations of motion can be used to determine the speed and if a PC storage oscillioscope is available, there is scope for investigation of output characteristics. Size: H5 x 6 x L38cm.

F4R05978 each **£24.99**

E Bell in a Bell Jar Experiment

An ideal solution to the common physics experiment demonstrating that sound will not travel in a vacuum. Place the bell jar on the pump plate, briefly connect the power supply. The bell can be heard ringing. Connect the vacuum pump to the pump plate and evacuate as much air as possible. Close the valve, switch off the pump and connect the power again. The bell striker moves but can barely be heard. Open the valve slowly, allowing air back in, and the volume of the bell increases.

The apparatus consists of a sturdy metal base plate mounted on a metal tripod. Baseplate dimensions 200 x 230mm (height x diameter). The bell jar comes complete with an electric bell that requires a suitable d.c. power supply (3–6V). Connection to a power supply is made via two 4mm terminals that protrude from the rubber stopper positioned at the top of the bell jar. Bell jar dimensions 260 x 180mm (height x diameter). Overall mass: 5kg.

F4L11149 kit **£58.90**

F Ball and Ring

For demonstrating thermal expansion. The ball will not pass if it is hot and the ring is cold, but will pass if both are hot or both are cold.

F4A42390 set **£5.50**

G Bar and Gauge

For illustrating expansion by heating and contraction by cooling. Comprising a bar of iron, 108 x 12.7mm length x depth, mounted on a support rod fitted with a wooden handle, and a brass gauge 150 x 38mm with a cut-out, which just admits the bar lengthways, and a hole which passes the bar endways when cold.
Length: 225mm approx.

F4A42407 each **£7.50**

H Bi-Metal Strip, Brass and Steel

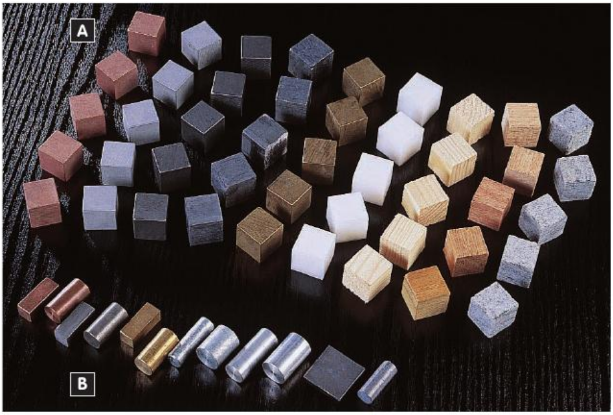
For demonstrating the differential expansion of 2 metals by the curvature produced when the strip is heated in a bunsen flame. Comprises strips of brass and steel, each 200 x 15mm, riveted together and mounted on a wooden handle. Overall length 320mm.

F4A42420 each **£5.50**

Wires for Young's Modulus

Contains 1 each of: 0.90mm bare copper, 0.71mm bare brass, 0.90mm bare brass, 0.56mm stainless steel, 0.71mm stainless steel, 0.90mm stainless steel. All 125g reels.

F4R06010 pack 6 **£33.99**



A Cubes for Density Investigation

Cubes for density investigation, 20mm.

F4H25146	Aluminium	pack 5 **£6.50**
F4H25158	Brass	pack 5 **£9.35**
F4H25169	Copper	pack 5 **£11.35**
F4H25171	Steel	pack 5 **£12.99**
F4H25183	Lead	pack 5 **£7.99**
F4A41324	Stone	pack 5 **£6.99**
F4H25195	Plastic	pack 5 **£6.99**
F4L78141	Set of all Materials	set 7 **£99.99**

B Metal Blocks

For density determinations. The set comprises two each of brass, iron, aluminium, copper, zinc and lead. Masses vary from 12 to 25g approx.

F4H25201	set 12 **£62.99**

C Expendable Steel Springs Extension

D37 x L25mm excluding loops, 58mm long overall. Wire diameter 1.5mm. Load required to just open coils 50g approx. Further 100g increments each increase spring length by 15mm approx. Max. recommended load 1.5kg.

F4A41415	pack 10 **£6.99**

D Set of Springs

An assortment of 180 compression and extension springs ranging from: 11 to 300mm in length, 3 to 15mm in diameter and 32 s.w.g. to 16 s.w.g. in wire thickness.

F4A81989	set 180 **£42.99**

E Ball Bearings

High quality steel ball bearings, available in 3 sizes.

F4R05984	25mm	pack 5 **£7.99**
F4R05985	13mm	pack 10 **£4.25**
F4R05986	3mm	pack 50 **£4.00**

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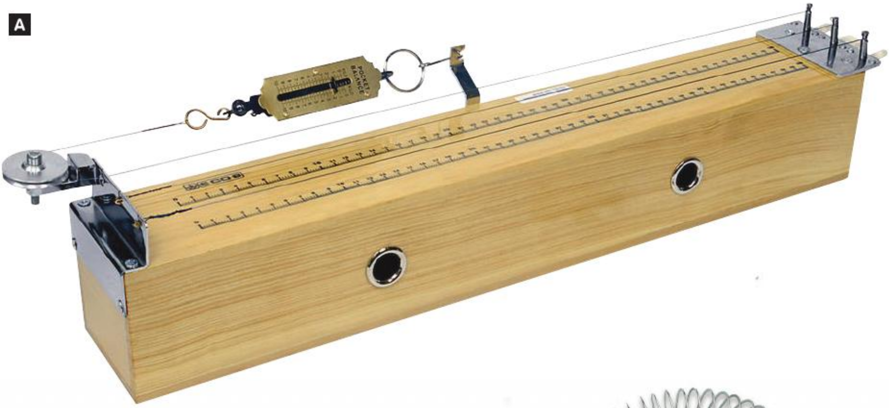
With our high quality equipment, you can set up fundamental experiments quickly and easily. They will help you to provide lessons on vibration and waves which will inspire your pupils and clarify key theories.



A Sonometer, 3-Wire Pattern

Appealing and elegant, the Sonometer is a classical device developed in order to study vibrating strings. With this apparatus it is possible to investigate the dependence of the pitch on the length, tension and thickness of a vibrating string.

Laws and principles investigated:

- Vibration frequency of a stretched string as a function of the length, tension and density of the string
- Frequency versus length
- Frequency versus tension
- Frequency versus mass per unit of length

Students can readily verify the dependence of the pitch on the length of the string, by inserting a bridge under the string at certain lengths. Two strings of different diameter can be put under tension with tuning machines: masses or a dynamometer can be attached to the other string. Strings may be sounded by bowing or plucking.

F4R01219	each **£62.99**

B Wire Helix (Slinky)

Ideal for demonstrating different types of waves. Flat-section steel wire in helical coil, diameter 75mm.

	Closed height	
F4A43485	55mm	each **£4.20**
F4A43497	110mm	each **£5.50**
F4A43503	165mm	each **£7.20**

C Steel Spring, Narrow

For transverse wave motion experiments showing standing waves through interference between two waves, reflection of waves and the inversion of the pulse, and the relationships between the initiating pulse, pulse length, wave speed, amplitude and frequency.

The spring is 20mm diameter x 3m long extending to 10m.

F4A43515	each **£19.99**

Spares and Accessories

Stainless Steel 304 Wire

15m coil of 0.45mm, 10m coil of 0.56mm, 10m coil of 0.71mm and 5m coil of 0.90mm.

F4R06073	pack 4 **£9.40**

Sonometer Wires, Brass and Steel

Set of six wires, brass and steel, length 1.5m, in three diameters 0.7, 0.56 and 0.46mm. Ends looped ready for use.

F4H25821	set 6 **£6.50**

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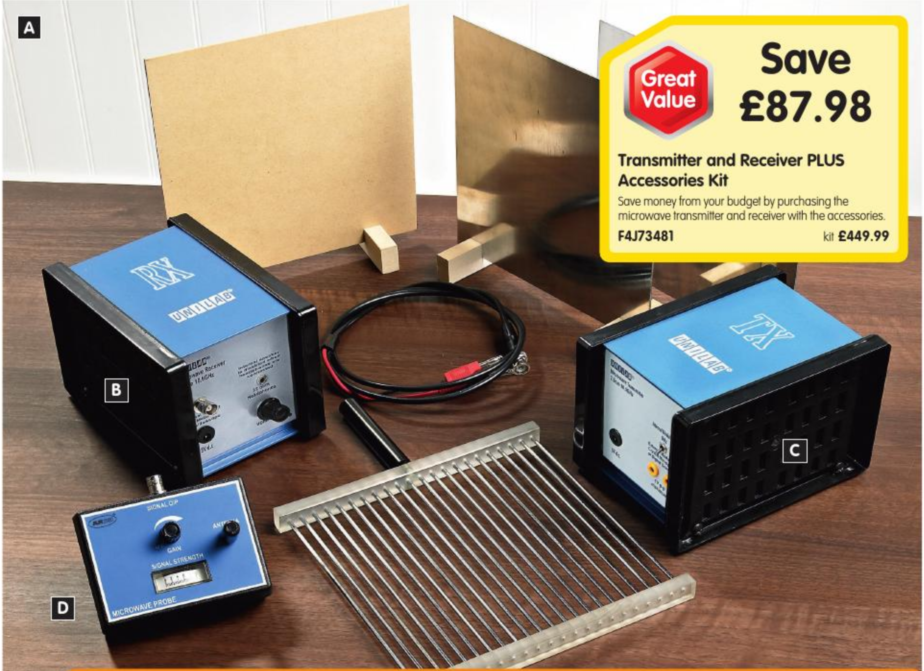


Great Value

Save £87.98

Transmitter and Receiver PLUS Accessories Kit

Save money from your budget by purchasing the microwave transmitter and receiver with the accessories.

F4J73481 kit **£449.99**

The microwave kit is robust and easy to use. Dozens of important and fundamental experiments can be set up in minutes – it could be the most valuable addition to your physics inventory this year.

A Microwave Kit with Accessories

Carry out experiments in Reflection, Refraction, Interface, Diffraction, Polarisation and Communication.

The transmitter and receiver have independent plugtop power supplies, making it easy to move and arrange on a bench top to illustrate a variety of E-M properties.

Using only the transmitter and receiver, students can explore polarisation and the effect of distance on signal strength. As an analogue of the behaviour of visible light, 2.8cm microwaves enable detection and interpretation of nodes and antinodes from simple measurements of the positions of the transmitter and receiver.

The transmitted signal can be modulated using either its own 1 kHz internal modulator, or an external signal source such as a microphone. The receiver has an internal demodulator and internal speaker (with headphone socket) to listen to the signal on the other end. A BNC socket allows you to observe the received signal on an oscilloscope or meter.

The microwave battery operated detector probe allows the student to measure and plot the microwave intensity at points in space, allowing observation of standing waves and interference patterns. It features a built-in amplifier, and a BNC socket allows signal output to an oscilloscope or meter.

From the INCLUDED Accessories Kit, the reflectors can be used to explore single and double slit effects in addition to reflection. Use a single reflector and the probe receiver to demonstrate Lloyd's mirror. The hardboard, semi-silvered mirror can be used to set up the Michelson-Morley experiment to prove there is no luminiferous aether!

F4R01946 pack **£549.99**

Transmitter and Receiver PLUS Accessories Kit

Save money from your budget by purchasing the microwave transmitter and receiver with the accessories.

F4J73481 kit **£449.99**

B Microwave Receiver

The receiver comes with a plugtop power supply, and is sensitive to plane polarised waves as emitted by the transmitter. It has an internal demodulator and speaker with volume control, headphone sockets and BNC output to an oscilloscope or meter. It replaces the old Unilab receiver 045.674.

F4J73479 each **£259.99**

C Microwave Transmitter

The transmitter comes with a plugtop power supply, and transmits plane polarised waves. It features a 1kHz internal modulator, and inputs for external signals. It replaces the old Unilab transmitter 044.672.

F4J73478 each **£252.99**

D Microwave Probe Receiver

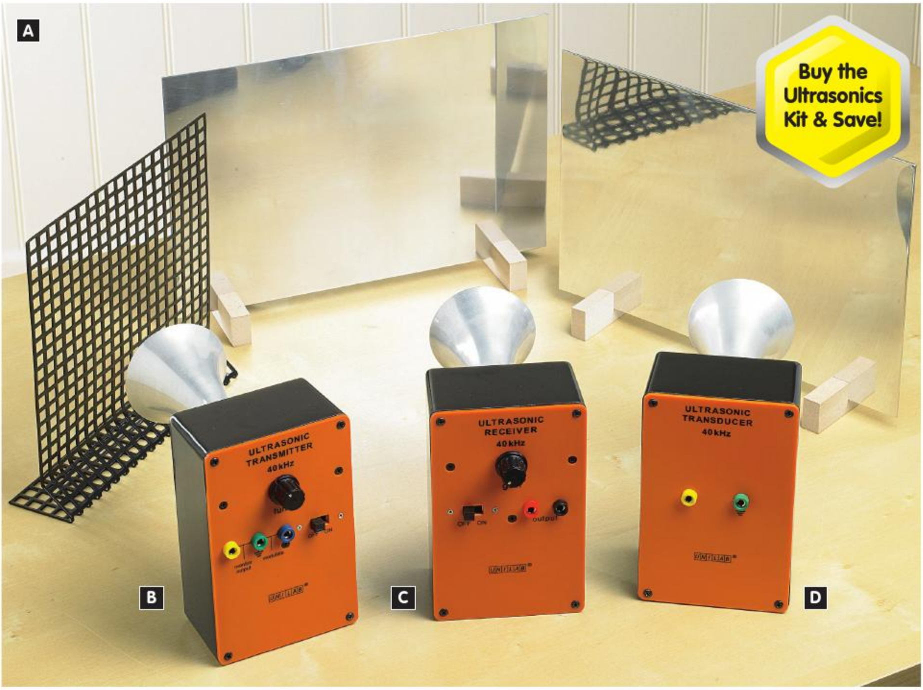
The battery operated microwave probe receiver is used to measure field strength at points in space, which is useful for standing waves and interference patterns. An internal variable gain amplifier and analogue meter indicates field strength, and a BNC socket allows connection to an oscilloscope or meter for more detailed observation and analysis. It replaces the old Unilab probe receiver 045.673.

F4R01939 each **£106.99**

Microwave Accessories Kit

- 2 aluminium reflectors 210 x 210mm with pairs of feet
- 1 aluminium reflector 210 x 60mm with feet
- 1 hardboard "semi-silvered" reflector 210 x 210mm with feet
- 1 polarisation grille

F4J73480 kit **£24.99**


A
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ULTRASONIC RECEIVER 40kHz
ULTRASONIC TRANSDUCER 40kHz
OFF ON
output
UNILAB
B
C
D

Helpful Hint

ULTRASONICS APPARATUS

- Investigations into reflection, interference, etc. using Doppler effect
- Possible to transmit speech over 100m distance
- SONAR system may be set up and demonstrated

This equipment operates at a frequency of 40kHz, giving a wavelength in air of approximately 8.3mm under normal atmospheric conditions. Detachable exponential horns increase the range and efficiency of the system. They also constrain the ultrasonic energy into the narrow directional beam required for certain experiments. Investigations into reflection, interference, etc. may be carried out. By pulse modulating the transmitter output a functional SONAR (sonic RADAR) system may be assembled. However, the longitudinal, unpolarised nature of the ultrasonic vibrations does not allow polarisation experiments to be performed as optical analogues. Individual units in the range are listed separately.

The transmitter and receiver units are supplied with equipment notes.

A Ultrasonics Kit

- Unique kit for convincing demonstration of the wave nature of sound
- Direct analogue of the properties of electromagnetic waves
- Units supplied with exponential horns

Consisting of a transmitter, receiver, slave transducer, two-reflectors and a perforated plate, this kit supports investigations of reflection, interference and diffraction of sound.

F4H76518 kit **£271.99**

B Ultrasonic Transmitter

Generates the 40kHz signal which is fed to the transducer cell and also to 4mm sockets on the rear panel of the unit. This latter facility enables a second transducer to be driven simultaneously, providing an in-phase double point source for interference experiments, etc. Facilities are also provided for modulating the output of the transmitter using an audio signal generator or audio amplifier/microphone combination. By this method the transmission of speech or other audio information is possible over a distance in excess of 100m. Requires PP9 9V battery (not supplied).

Dimensions: case 150 x 95 x 60mm, horn 75 x 100mm mouth diam. x length.

F4H29231 each **£126.99**

C Ultrasonic Receiver

Identical dimensions to the transmitter. The transducer is of the same type as used in the transmitter but in this case used as a detector, its output being applied to a d.c. amplifier circuit. A pair of 4mm sockets allow connection to a 1mA meter for quantitative work. A gain control is also provided so that the output from the receiver provides full scale deflection of the meter under maximum signal conditions. If speech or other audio modulation is used the output from the receiver should be connected to an audio amplifier/loudspeaker combination.

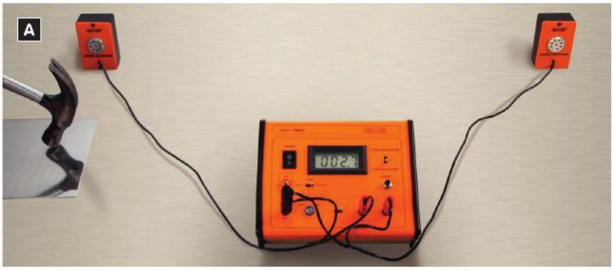
Requires 9V PP3 battery (not supplied).

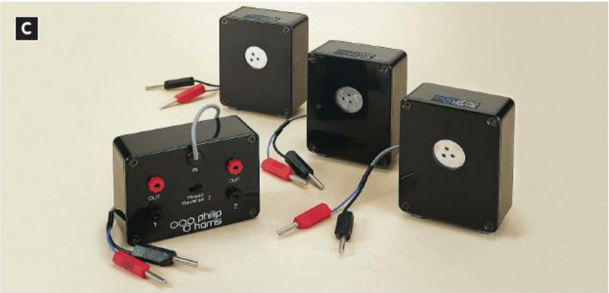
F4H29255 each **£126.99**

D Ultrasonic Transducer

Similar to the transmitter and receiver, but containing only a transducer cell. Designed to be connected in parallel with the output from the internal oscillator of the main transmitter to produce an identical output allowing experiments in double point-source interference, etc. to be carried out.

F4H29243 each **£66.99**





A Speed of Sound Kit

- Direct method for measuring time taken for sound to travel a known distance
- The Fast Timer can be used in many other experiments

This kit provides a direct method to measure the speed of sound. Timing to microsecond accuracy is started and stopped as sound passes the microphones - see the experimental diagram. A small hammer and metal plate is included in the kit to make the necessary sharp sound. The Fast Timer, when used with mechanical start/stop gates, has many other applications e.g. in the measurement of g by free-fall.

F4H76488 kit **£207.99**

B Ceramic Microphone

This high impedance, high sensitivity unit may be used with a power amplifier for public address or connected directly to an oscilloscope (page 77) to show audio waveforms. Fitted with 90cm screened flex and two 4mm plugs.

F4H27581 each **£22.10**

C Sound Wave Demonstration Set

Apparatus for investigating wave phenomena using sound. The efficient transducers may be driven by the output from a standard audio signal generator, and their sensitivity as receivers is such that they may be used directly on the 5mV input of an oscilloscope.

Detailed equipment notes are provided covering investigations into: reflection and refraction; interference patterns in air; detection and measurement of phase differences in a signal received by two receivers; measurement of wavelength using the phase difference between transmitter and receiver etc.

Units are housed in boxes 100 x 75 x 40mm and the set comprises three transducers and one control box as follows:

- Transducers may be used as either transmitters or receivers. Electrical connection via 2m screened lead with 4mm plugs.
- Control box having 1m of screened input lead with 4mm plugs, & two pairs of 4mm output sockets. Switch permits phase reversal between the two outputs.

F4H30877 set **£102.99**

D Tuning Forks

Excellent quality aluminium plain shank tuning forks with frequency marked on. Set of 8 containing: A 426Hz, B 480Hz, C 256Hz, C 512Hz, D 288Hz, E 320Hz, F 341Hz and G 384Hz. Supplied in a wooden box for storage.

F4R05153 set **£33.65**

E Audio Amplifier and Loudspeaker

300mW amplifier with variable gain and input impedance of 1MΩ with connecting lead (co-axial to 4mm plugs).

Power: internal 9V 150mAh rechargeable battery

Mass: 0.6kg

Size: 150 x 95 x 60mm

F4H29565 each **£121.99**

F Loudspeaker

A 75mm diameter, circular loudspeaker of 8Ω resistance. Contains a high flux ceramic magnet of nominal power rating 5W. Mounted in a rectangular plastic case and with two 4mm sockets for connection. Despite its relatively small size this unit will provide a useful level of sound over the whole audio frequency range.

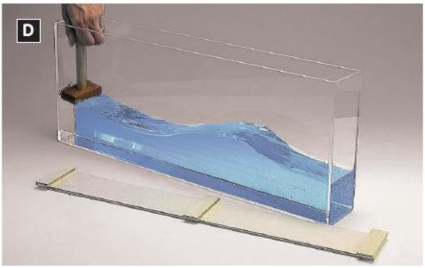
Dimensions: 150 x 135 x 40mm.

F4H27441 each **£24.50**

G Aluminium Tuning Forks

Precision made, these tuning forks are approximately 120mm long.

F4R06047	Note A 426Hz	each **£6.49**
F4R06046	Note C 256Hz	each **£6.49**



A Ripple Tank

Complete with all accessories needed for wave investigations Intensely illuminated for effective student observations Built in projection screen Reinforced frame with foam beaches.

This advanced ripple tank comes complete with all accessories needed for wave investigations. Tank is intensely illuminated by a strong light source, and synchronised with the wave generator to help students observe the wave patterns on a workgroup table. The frame is made of reinforced plastic and with foam beaches (to negate reflections). Includes a mirror, which can be mounted at 45 degrees, to project the ripples onto a translucent screen on one side of the unit. Each water wave acts much like a curved lens. The crest of the wave is seen as a bright region and the the trough is seen as a dark region. Inside the ripple tank is a mechanical vibrator attached to a wave generator that produces either point wavelets or parallel wave fronts. Various obstructions and barriers can be inserted into the path of the wave, such as a single slit, a double slit or an edge. Size: L62 x W39 x H23cm.

Includes:

- Vibration Generator
- Wave monitor unit
- Projection screen
- Wave dippers
- Lever arm and support
- Ripple tank
- Projection mirror
- Set of footers with adjustment screws
- Set of lucite/perspex objects

F4R05994 each **£146.95**

B Xenon Stroboscope

If something is spinning, oscillating or vibrating very fast, how can you see it? A stroboscope gives the illusion of slowing down, freezing, or even reversing the action.

This robust, lightweight stroboscope is ideal for classroom work with vibrations and waves. It features a bright xenon tube that is effective even in low ambient light, meaning complete blackout is not necessary.

Control of flash frequency is by way of intuitive controls, in the range 0.2-300Hz. Coarse adjustment is by multiplier buttons and fine adjustment either by up and down buttons or by analogue-style dial. An external signal can be used instead, such as a signal generator or manual trigger. The unit resets to 1Hz for safety when switched on.

A large LED display shows the frequency setting when using the internal modulator, and will display the frequency of the incoming signal if the external trigger is used. The unit features a carrying handle and is powered via a mains lead. It is an excellent aid when doing experiments with the Vibration Generator and Accessories, or ripple tanks. Watch musical instruments deform as they're played, and measure the speed of objects as they move through space.

F4H30359 each **£229.99**

C Doppler Ball

Did your students ever wonder why a train gets louder as it approaches? Why not show them the physical phenomenon known as the doppler effect with the battery driven device. Load the batteries, swing it in a full circular motion and your students will experience the doppler effect first hand.

F4R05981 each **£12.99**

D Large Rectangular Tank

For refraction, reflection and wave demonstrations. The tank is transparent, long and narrow to give an adequate path length for wave experiments. A wave generator in the form of a plastic block with handle is provided. Dimensions: 600 x 75 x 200mm.

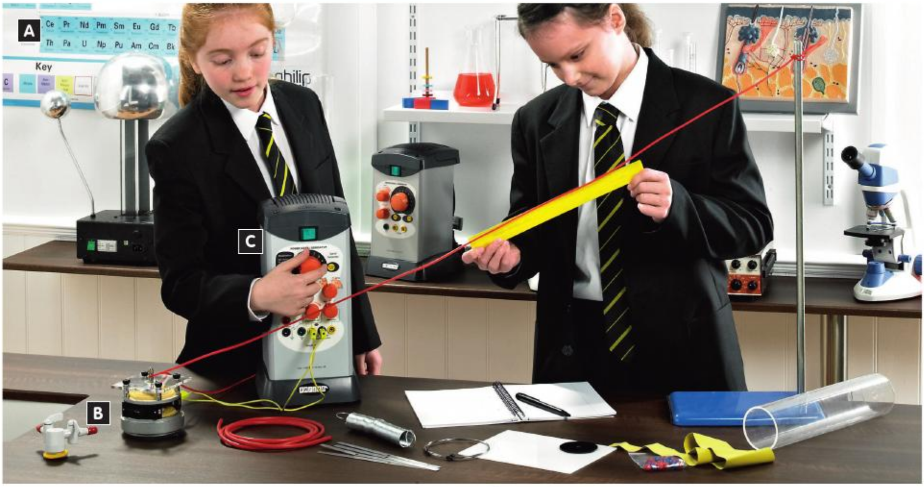
F4A43758 each **£99.99**

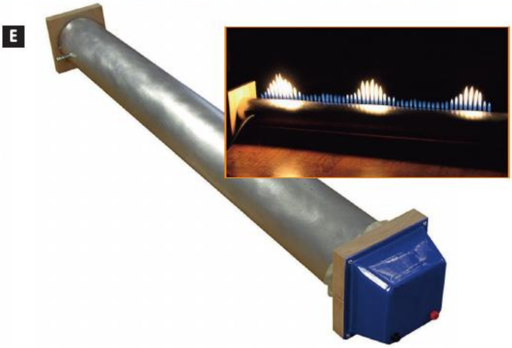
Spares and Accessories

Ripple Tank Illuminant

Comprising a straight-filament projection type lamp, 12V 21W, S.B.C., mounted in a conical lamphouse and provided with a long supporting rod for attachment to a retort stand. Electrical connection to the lamp is via 4mm plugs.
Dimensions of rod: 500 x 10mm diameter.

F4H25754 each **£46.99**





A Vibration Generator Kit

This kit consists of The Vibration Generator and the Accessories Kit.

The Vibration Generator gives mechanical oscillations when fed by signals from a Power Signal Generator. The frequency response encompasses the whole of the audio spectrum and beyond.

- Maximum peak to peak displacement: 12mm
- Total frequency range: d.c. to 10kHz

Accessories are attached to the centre of the Vibration Generator and allow thorough investigations into vibrations and waves, including longitudinal and transverse waves, and standing waves. Attach the Chladni plate to observe modes of vibration on mechanical surfaces, which affects musical instruments, appliances and vehicles. Build a kinetic theory model to introduce the concept of vibrations at the molecular level.

F4R03088	kit **£62.50**

B Vibration Generator

Gives mechanical oscillations when fed by signals from an oscillator/A.F. amplifier. A special high temperature coil system enables the unit to be operated at its maximum rating for a prolonged period without damage due to overheating.

F4H31134	each **£61.99**

C Power Signal Generator

The power signal generator is a versatile device, enclosed in our SpaceSaver case. It can produce a wide range of signals, from 0.1Hz to 110kHz, with an output power of up to 5W. There are low and high impedance outputs, with the low impedance protected by a time delay fuse. The unit features an internal speaker that can be turned on and off, and can be used to demonstrate the range of human hearing (from 20Hz up to 20kHz).

Frequency control is via a 6 position decade dial and a large continuous dial which controls a multiplier from x1 to x11. There are also dials to control amplitude from 0V to 5V, and attenuation on the high impedance output. Buttons control the shape of the function (sine, triangle, square and TTL), turn the internal speaker on or off, select the modulation mode, and between auxiliary or internal signal. There are inputs for signal modulation by an external signal, which can be a.m. or f.m., for exploring different types of radio signals, and an auxiliary input for amplification of an external signal instead of the internal function generator, such as from a microphone or music player.

This instrument is ideal for powering large speakers, and is necessary for driving the vibration generator to explore vibrations and waves.

F4G85793	each **£289.99**

D Vibration Generator Accessory Kit

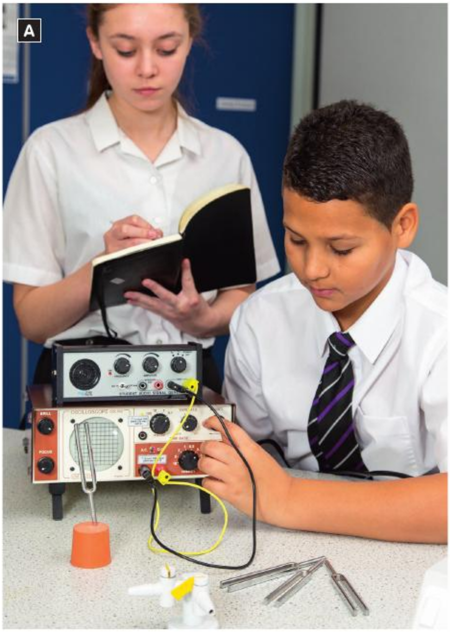
The kit contains items for demonstration of standing waves - longitudinal, transverse and two-dimensional. Demonstrate with the coil spring, thick and thin rubber cords, tapered rubber strip, chladni plate, loop of piano wire and steel strips. The 3D kinetic model has a transparent tube and 20 coloured plastic balls to represent molecules of a gas or liquid.

F4H30920	kit **£19.99**

E Rubens' Tube

Intended for teacher demonstrations only. The Rubens' Tube is an Aluminium tube with a row of small holes drilled along the top and 100W loudspeaker mounted at one end. Full instructions included. Users will need a gas source (Natural or LPG) and a signal generator to run the speaker. Size: 900 x 100mm.

F4R05634	each **£339.99**



A Student Oscilloscope

- Inexpensive, single channel oscilloscope with simplified control layout for student operation and permanent triggering feature
- Introductory unit to teach the basics of oscilloscope use with a useful set of features e.g. 8 switched gains from 50mV to 10mV per division and a timebase with switched ranges of 1, 10, 100 or 1000ms across screen with variable x 1 to x 10 control

This extremely popular educational oscilloscope is robust and easy-to-use. The flat screen is 70mm across a diagonal with graticule marked in 10 x 10 0.5cm squares. Focus, Brilliance, X shift and Y shift controls determine the position and nature of the trace. A Y input can be passed to the Y amplifier directly or through an internal capacitor to block a d.c. component. Note that with the slowest timebase setting, the spot takes 10s to cross the screen, ideal for slow analogue computing investigations. The start of the spot from the left-handed edge of the screen is synchronised automatically to the positive-going edge of the Y input. (N.B. this may mean that the track takes about 1s to settle down if the Y position is altered). The time base may be switched off and the X input p.d. used to control the horizontal position of the spot, e.g. in Lissajou's figures. Student audio signal generator not included.

The steel case is fitted with 1.8m of mains cable, a carrying handle which can be used as a tilt stand, an on/off switch with indicator LED, and cable wraps at the rear.

- Y amplifier: FET input, 1MΩ d.c. to 10kHz
- X amplifier: 1MΩ d.c. to 100 kHz
- Syn. Input: 1MΩ input, triggering at 20mV
- Mass: 3.8kg
- Size 245 x 310 x 105mm

F4H28226 each **£381.99**

B Owon Oscilloscope

- 30MHz bandwidth
- 250mS/s per channel
- ≤5.8ns rise time
- 8 inch colour TFT LCD display
- Dual channel with external trigger
- Normal sample, peak detect and average sampling mode
- Record length: Max. 10,000 points per channel
- Sampling range: 5S/s~250mS/s for single channel and 1S/s-125Ms/s for 2 channels
- Horizontal scale: 4n/s div to 100n/s div in steps by 1-2-5
- Vertical sensitivity 5mV ~10V/div
- DC gain accuracy ±3%
- Max input voltage 400V (PK - PK)(DC+AC PK-PK)
- Input Impedance 1MΩ±2% in parallel with 20pF±5F
- Input Coupling: AC DC GND
- Trigger Mode: Edge video with holdoff function
- Vertical Resolution: 8 Bits
- Sampling Rate: ±100ppm
- Interval Accuracy: Single ±(1 interval time + 100 ppm x reading + 0.6ns) Average 16: ±(1 interval time +100ppm x reading +0.4ns)
- Waveform Storage: 15 waveforms
- Automatic Measurement: Peak-to-peak, Average, RMS, Frequency, cycle, Vmax, Vmin, Vtop, Vamp, Overshoot, Preshoot, Rise time, Fall Time
- USB interface
- Dimensions 350 x 157 x 80mm

F4R05267 each **£264.99**

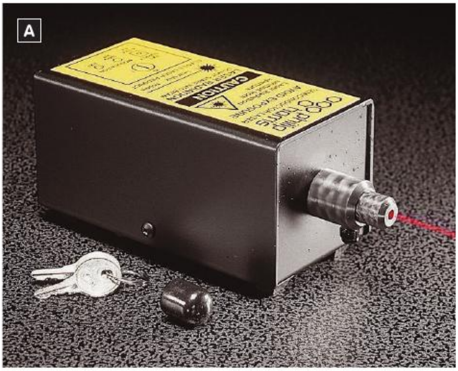
C Oscilloscope

Features:

- Ultrathin Oscilloscope, small in size and more portable
- A 7-inch widescreen colour TFT LCD displays clear, crisp and more stable waveform display. 25% more viewing area with the menu switched off
- Various trigger functions: Edge, Pulse, Video, Slope and Alternation
- Unique digital filtering and waveform recording functions
- Pass/Fail function
- 32 kinds of automatic measurement and manual cursor tracking measurement functions
- 2 groups of reference waveforms, 16 groups of common waveforms, 20 groups of internal storage/output; support waveform setting
- External storage and output of CSV and bitmap file by USB flash disc (CSV and bitmaps cannot be output from USB flash disc)
- Adjustable waveform brightness and screen grid brightness
- The pop-up menu display mode is more flexible and more natural for users' operations
- Various kinds of language interface display, Chinese and English
- On-line help system
- Shortcut key to PRINT, support print screen
- Standard configuration interfaces: USB Host, USB Device, RS-232
- USB Host: support storage of USB flash disc and upgrading of USB flash disc system software
- USB Device: support PC connection for remote communication
- 1GSa/s sampling rate
- 2 Channels
- 7" Widescreen LCD color display
- USB Host/Device: Support USB printer and USB flash drive
- PictBridge function
- Easyscope software
- Contains: User manual, product warrenty card, 1:1/10:1 probes (2 pieces each), USB cable, CD (containing PC software GAScope1.0)

F4R05916 each **£404.99**

A



C

B

A Philip Harris Semiconductor Laser

A compact fully solid state instrument which produces an intense beam of light at a wavelength of 630nm and can be mounted directly upon a standard type optical bench. An adjustable collimator is incorporated providing focusing facilities and control over beam divergence. A useful feature is the modulation facility which permits experiments in laser communications and speed of light investigations to be carried out. Modulation may be by means of the built-in oscillator, or from an external signal source. For these applications an accessory receiver unit is available. A key operated ON/OFF switch is incorporated. (Please contact customer services if a spare key is required).

- Power output: 0.9mW nominal, 1mW absolute maximum
- Category Class: 2 with Wavelength 630nm
- Beam divergence: 1 mrad approx. at optimum focus
- Modulation capability: Analogue or digital
- Internal modulation: pulsed at 1MHz, pulse width 0.1µs
- External modulation: 1V peak to peak max., 100Hz to 1MHz, input impedance 50Ω
- Modulation input connectors: 3.5mm jack sockets
- Operating voltage: 8 to 12V d.c. from internal PP3 type battery (alkaline recommended), and from smoother and regulated source via 'power in' socket
- Current consumption: 50mA typical, giving approximately 9 hours operation from alkaline PP3
- Dimensions: 160 x 65 x 72mm overall (including collimator)
- Mass: 400g

F4A46139 each **£216.50**

B Solid State Laser

Designed for safety the laser is now very low-power (1mW) and is protected by a key switch to prevent it's unsupervised use. The power output places the laser in 'Class 2' as recommended for use in schools and colleges. No damage is likely should a stray reflection of the beam enter the eye at such low power.

The wavelength of the light is 635nm which compares favourably with the helium-neon wavelength of 632.8nm.

Additional features include:

- Tapped (M5) exit hole for possible mounting of optical components, fibres etc. Closest to the point of emergence of the beam
- Laser support arm (from the laser accessories kit) connects to a tapped mounting point and allows the laser to be supported using an ordinary clamp stand and boss
- Metal case fitted with 1.8m of mains cable, illuminated ON/OFF switch, locking key switch with 2 keys
- 250mA fuse

Wavelength: 635nm. Beam diameter: 6mm at 5m. Divergence: 3mrad

F4H83651 each **£349.99**

C Modulated Laser Receiver Unit

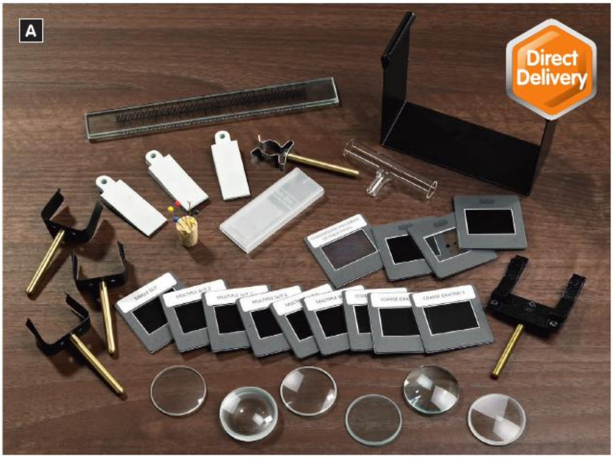
For demonstrating the transmission of information via a modulated laser beam, and for simple speed of light determinations. It includes a self contained receiver unit comprising an opto-detector coupled to a wide band amplifier.

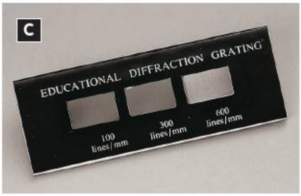
A miniature speaker is incorporated to provide an audible signal from modulation frequencies within the audio frequency range, although if 'demonstration level' volume is required, a separate amplifier/speaker system is recommended. Powered by a 9V PP3 battery, ON/OFF switch incorporated.

- Frequency response (opto-detector/amplifier): 100Hz to 5MHz
- Dimensions: 120 x 65 x 35mm

F4A46176 each **£65.99**

NO HASSLE RETURNS
Order in confidence!
See the front of the catalogue for details





A Laser Accessory Set

A set of compatible items which will enable diffraction to be investigated with slits, gratings, pinhole spots and other obstacles. The set comprises:

- 1 Set of six lenses, focal lengths -100, -50, +50, +100, +200 and +1000mm
- 3 Lens holders
- 1 Slide holder for 50mm square slides
- 1 Pinhole slide, 50mm square, with holes of 0.2, 0.1 and 0.05mm
- 1 Slide with single and double slits
- Set of six slides with 1, 2, 3, 4, 5, and 6 slits respectively
- 1 Set of three diffraction grating slides of 150 and 300 lines
- 1 Air cell for refractive index of gases. Path length 75mm approx.
- 2 Microscope slides 76 x 25mm
- 1 Glass scale 200 x 25 x 6mm, scale 0 to 150 mm x 1mm
- 1 Support stand for glass scale
- 1 Slide, 50mm square with circular obstacles for Fresnel diffraction
- 6 Bead headed mapping pins and needle for Fresnel diffraction
- 1 Hologram (ready prepared)
- 1 Copy of Manual of School Laser Demonstrations

Direct Delivery – up to 4 weeks

F4H26151 set **£288.99**

B Beam Splitter

For splitting a light beam (especially a laser beam) into two equally intense beams. Comprises a pair of mirrors arranged in a periscope configuration. One mirror is semi-silvered to transmit half the light and reflect the other half on to the second mirror. An adjustment is provided to vary the horizontal separation of beams from 18 to 45mm approximately, and another adjustment gives rotation of the one mirror through an angle of 20°. Mounted in a 25mm square section tube with 6mm diameter peg to fit Philip Harris optical stands.
Overall length: 90mm. Supplied complete with a copy of Manual of School Laser Experiments but WITHOUT stand.

F4H26163 each **£109.99**

C Diffraction Slide

Comprises a card mount 90 x 40mm approximately with three 16 x 9mm apertures, each containing a diffraction grating replica.

F4A46231 each **£20.99**

D Gratings and Slits

Set of nine slides in 50 x 50mm mounts, six of them having a series of slits, numbering from 1 to 6, each slit approximately 0.0625mm wide and separations between slit centres of 0.25mm. The other three slides are coarse gratings with the following features:

- 150 slits with the same width and separation as the multiple slits above
- 150 slits, half the width but with the same separation
- 300 slits, half the width and half the separation

Direct Delivery – up to 10 days

F4H26175 set **£61.99**

E Young's Slits

Photographically reproduced double slit 10mm long x 1mm separation protected by glass plates and framed in a 50 x 50mm mount.

F4H26138 each **£13.50**

Spares and Accessories

Slit Slides

F4R06222	Single	each **£9.99**
F4R06223	Double	each **£9.99**

A Speed of Light Kit

- Supplied in a Gratnells tray
- Unique kit for the measurement of 'c' directly, within the dimensions of a science laboratory
- Simple to understand method
- Comparison of 'c' in air with that in the plastic of a fibre optic cable for direct calculation of refractive index

The apparatus consists of a transmitter and receiver, two Frensel lenses with holders, a mirror, plug-top power supply, all connecting leads and instruction booklet.

A double-beam oscilloscope is required (not included), which has an external trigger, a bandwidth of at least 20MHz and time-base with a resolution of 20ns per division.

The transmitter contains a high intensity LED pulsed at 1MHz and provides a synchronisation pulse to the "ext. sync" sockets of the oscilloscope. The light pulse travels are displayed as 'Y1' on the oscilloscope. The light pulses travel to the receiver, where its signal is displayed as 'Y2'. The experiment is performed twice, once with the transmitter and receiver directly aligned 1 metre apart, the second time with the pulses travelling across the laboratory to the mirror and being reflected back.

By measuring the difference in the position of the Y2 trace in the two cases the time (typically 0.1µs) for the return journey across the laboratory (typically 30m) the speed of light can be calculated.

F4H82993 kit **£339.99**

B Comprehensive Fibre Optics Kit

This system enables the basic properties of optical fibres to be investigated and the ideas then extended to demonstration of some of the principal scientific and commercial uses. The low-cost plastic fibre may be cut to any desired length with a sharp knife and does not require any special terminating devices. It is also completely non hazardous. The system comprises a transmitter, a receiver (both built onto P.C. boards 120 x 150mm) and a 25m length of optical fibre. 20m of this is intended for speed of light determination and long distance communication demonstrations.

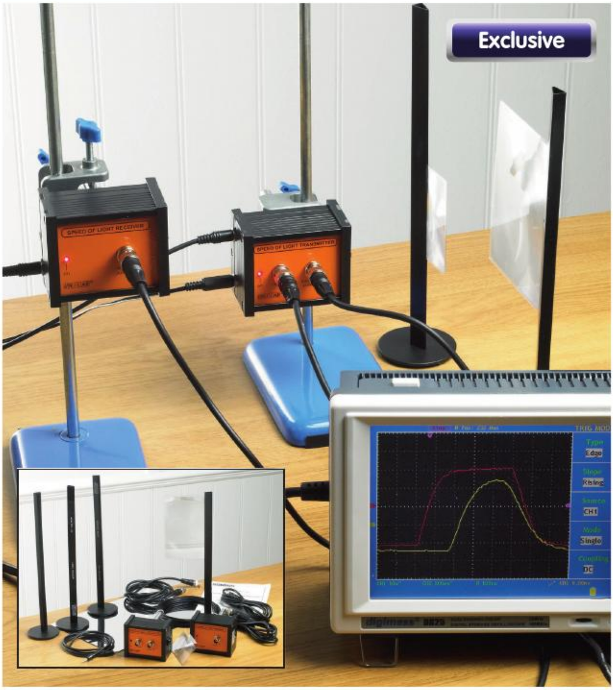
Transmitter

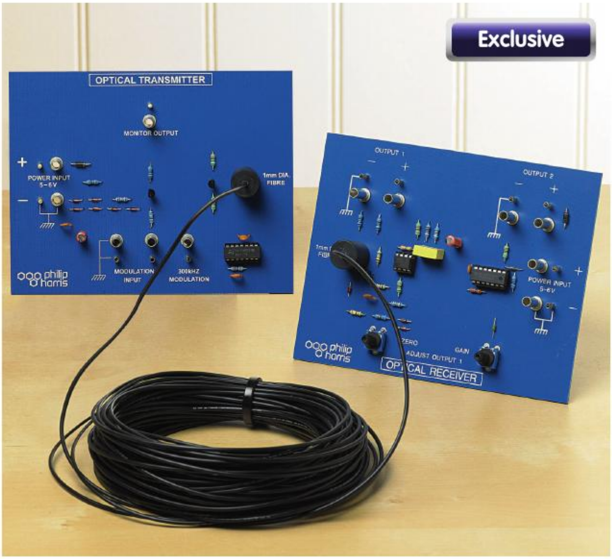
- Light source: High intensity red LED, output at 630nm
- Modulation: Internal or external. The internal modulation source is a 300kHz oscillator (normally used for the speed of light experiment)
- External modulation input: 0 to 2V d.c. linear, up to 5V digital, or a.c. coupled via external capacitor (not supplied)
- External modulation frequency range: d.c. to greater than 300kHz, TTL compatible
- Monitor output: 0 to 2.5V, for connection to an oscilloscope, or to measure the LED operating current
- Power requirements: 5 to 6V smooth d.c., reverse polarity protected
- Terminations, Optical: simple push in connection for 1mm diameter optical fibres
- Terminations, Electrical: all connections by both 2mm and 4mm sockets

Receiver

- Input: Solid state photo-detector
- Output 1: d.c. to greater than 5kHz, for connection to meters etc. and general analogue audio signals
- Output 2: High speed digital output, 0 to 5V from below 20Hz to above 300kHz
- Controls: Two, providing for zero-set and gain on output 1
- Power requirements: 5 to 6V smooth d.c. reverse polarity protected, (the transmitter and receiver may share the same power supply if desired)
- Terminations, Optical: simple push-in connection for 1mm diameteroptical fibres
- Terminations, Electrical: all connections by both 2mm and 4mm sockets

F4H28627 kit **£223.99**





CROSS REFERENCE

Philip Harris Semiconductor Laser see page 59

An excellent low-cost resource for an introduction to the study of optics, the wooden optical bench is a versatile piece of apparatus with a wide range of available accessories. Using a lens holder and a screen, the powers of different lenses can be measured and real and virtual images discussed. By mounting a laser, ray optics can be investigated, and phenomena such as interference patterns can be observed with the Young's Slits accessory.

A Optical Bench, Wooden, 1.5m

Wooden baseboard 1.6m x 140mm with a 1.5m scale divided in mm plus six sliding moulded bases 100 x 50mm each with index line, brass pillar and locking screw. The following accessories are included:

- 1 lamphouse with a white 240V lamp LED
- 1 white metal object screen 75mm in diameter with gauze
- 1 holder for lenses, 38mm diameter
- 1 white metal receiving screen, 100 x 75mm with a slot for squared paper screen on the reverse
- 1 object needle mounted in 6mm brass rod
- 1 Plane mirror in a metal frame 100 x 75mm

Each of the accessories is mounted on a 6mm brass rod which fits into the stands giving an optical height 125mm above the base board.

F4H89963	each **£142.99**

B Young's Slits

Photographically reproduced double slit 10mm long x 1mm separation protected by glass plates and framed in a 50 x 50mm mount.

F4H26138	each **£13.50**

C Stand for Lens Holder

Metal pillar with clamping screw to support rods of 6mm diameter as used on standard optical bench fittings. Base dimensions: 100 x 50mm.

F4H26102	each **£14.99**

D Lamp, 12V

Uses 12V 24W S.B.C. projection lamp with lead and 4mm plugs.

F4H76580	each **£11.99**

Lens Holder, Clip Pattern

Designed to provide a firm grip on 38mm diameter lenses.

F4H25997	each **£9.99**

E Holder for Diffraction Objects

Rectangular metal frame with spring clips and a mounting rod. Dimensions: 105 x 55 x 10mm.

F4H26011	each **£19.99**

F Lens Holder, Adjustable, Simple Pattern

V-section with hinged arms to take any lens or mirror up to 75mm diameter.

F4H26009 each **£16.50**

G LED.white

- No blackout required
- Excellent alternative to traditional rayboxes
- Gives a better white than conventional lamps
- Powered by a 5V plugtop (supplied)
- Long life, low power LED (1 watt 10,000 hours) instead of a 24/36W bulb
- Runs cooler than traditional ray optics boxes
- Voltage cannot be 'accidentally' increased and blow the bulb
- Improved design with integral slit plate holder

LED.white can be used in most experiments in place of a ray box and offers many advantages. Spectra produced using prisms or diffraction gratings are bright and clear, from red through to violet. It can be mounted on a retort stand or optics bench using the mounting rod in the LED.white experiment kit. Includes an experiment guide on CD.

F4L87348 each **£59.99**

B

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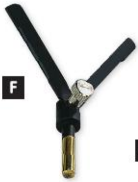
E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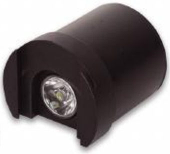
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A LED.modulator

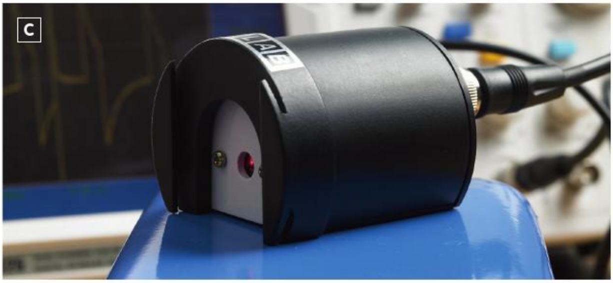
The LED.modulator is designed to modulate the intensity of the LED.laser or LED.white with an analogue signal.
Signal is input via either a pair of 4mm sockets (for example – from a signal generator), or a 3.5mm audio jack, for connection to an MP3 player or other audio source.
A 1MHz internal generator is also available that allows direct measurement of the speed of light, when used with the LED.laser and a dual trace oscilloscope.
Input selection is via a control panel, and is indicated via an LCD.
A captive driver lead delivers power and signal to the light source of choice, and a BNC socket allows the output signal to be observed on an oscilloscope simultaneously.
As the unit modulates the power to the light source, a power supply is not required – simply use the LED.laser or LED.white's own plug-top supply.
Note: 4mm plug leads or a 3.5m plug-to-plug lead is required to connect the signal source, and a BNC plug-to-plug lead is required to view the signal on an oscilloscope.
An experiment guide is included on CD.

F4R04837 each **£94.99**

B LED.strobe

The LED.strobe produces a square wave signal, whose frequency can be varied from 1-200Hz in 1Hz steps, and whose duty cycle can be set between 10 and 50% in 5% steps.
The square wave is used to modulate the power to the LED.white or LED.laser (not included), allowing them to be used in experiments involving stroboscopy.
With the LED.white, the fast moving objects can be slowed down or frozen, allowing easy observation of motion, and discussion of the uses and effects of a strobe.
Interesting patterns can be projected by using the LED.strobe with the LED.laser.
As well as internal modulation, the unit has 2 x 4mm sockets for triggering from an external source, such as a signal generator or audio.
Control of the frequency and duty cycle is via a keypad, and settings are indicated via an LCD.
As the unit modulates the power to the light source, a power supply is not required – simply use the LED.laser or LED.white's own plug-top supply.
An experiment guide is included on CD.

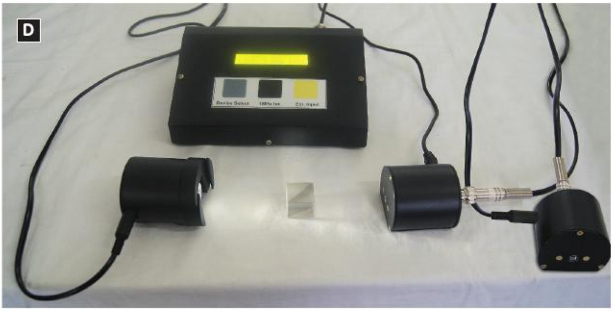
F4R04838 each **£94.99**



C LED.Rx

The LED.Rx is used to receive and demodulate light from the LED.laser or LED.white, which has been modulated using the LED.modulator.
The light is collected by a phototransistor on the front of the unit, which is white for easy aiming of the laser beam over greater distances.
A BNC socket at the back outputs the demodulated signal. When connected to an audio amplifier, the signal carried by the laser can be heard. Alternatively, the signal can be observed on an oscilloscope.
The LED.Rx responds to the 1MHz signal produced by the LED.modulator, and by comparing the source and received signals on a dual-trace oscilloscope, it is possible to measure the speed of light.
It is housed in a convenient flat-bottomed cylindrical housing for work on the bench, and a boss on the back allows mounting on a retort rod.
Note: a BNC plug-to-plug lead is required for connection to an oscilloscope.
A plug-top power supply and an experiment guide are included.

F4R04836 each **£73.99**



D LED.laser

Used on its own, the LED.laser can be used to investigate reflection, refraction, diffraction and interference.
It can also be driven by the new LED.modulator, which allows the intensity to be modulated with an analogue signal. The signal can then be received with the LED.Rx, which can demodulate the signal for output to an audio amplifier or oscilloscope. By modulating with a 1MHz signal, the speed of light can be measured directly.
The laser has a convenient flat-bottomed cylindrical housing for work on the bench, and a boss on the back allows mounting on a retort rod.
The wavelength is 640nm, and is a class II unit with a power output of <1mW. A plug-top power supply and an experiment guide are included.

F4R04839 each **£54.99**

Our Own Design

Spares and Accessories

Low Voltage Bulbs - 38mm

With straight axial filament; double contact; S.B.C. Dimensions 55 x 38mm diameter approx. For Philip Harris Ray Optics Box B8H77468.

F4A56820 12V 24W each **£1.30**

Festoon Lamp 12v

12v Festoon Lamp suitable for the Economy Science Ray Optics Box B8H77390.

F4A91753 each **£1.70**

Collimating Lens for Ray Box

Spare collimating lens for Ray Optics Boxes.

F4G98635 pack 5 **£12.99**

Slit Plate for Low Cost Ray Box

Spare slit plates for Economy Science Ray Optics Box B8H77390. 45mm x 75mm. Suitable to be used with both the Ray Optics Box and Battery Operated Ray Optics Box.

F4G98647 pack 5 **£3.25**

Spare Slit Plates

Spare slit plates for Philip Harris Ray Optics Box B8H77468. 50mm x 100mm.

F4L26955 pack 5 **£8.99**

Spare Lens

Spare 50mm double convex cylindrical lens for Philip Harris Ray Optics Box B8H77468.

F4R01336 each **£9.50**

A Ray Optics Box

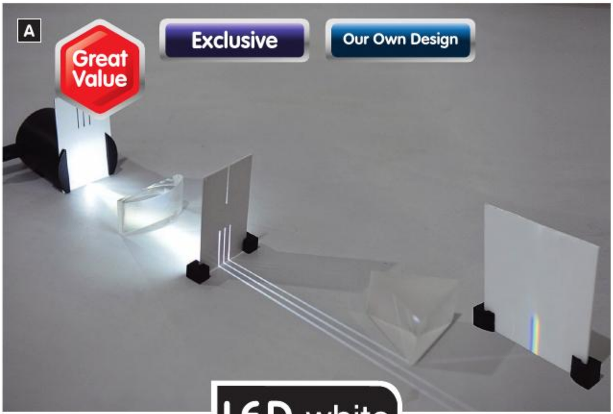
A ventilated Ray Optics box open fronted with extended sides finned externally for heat dissipation and vertical internal grooves to accommodate a slit plate and cylindrical lens. It includes a 12 volt, 21 watts lamp with one meter of twin flex ending in 4mm connectors, a single and triple slit, whitened on one side, black matt on the other. Operates on 12 volts power supply which is not included.

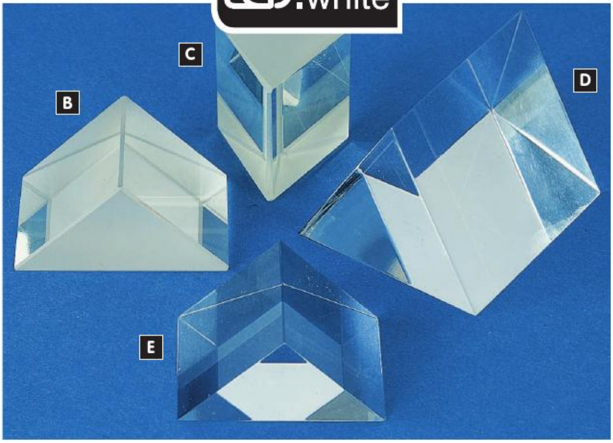
F4R06342 each **£31.99**

B Battery Operated Ray Optics Box

A battery operated LED Ray Box comprising of a die cast enclosure which delivers white light but runs much cooler than conventional incandescent lamp models. It uses the latest cool ultra bright LED technology giving superior white light. Supplied complete with slit plate and its own battery power source using 2 x AA size batteries (not supplied).

F4R06343 each **£56.99**





A LED.white Experiment Kit

The accessory kit complements the LED.white and includes:

- Collimating lens
- Slit plate and holder
- Mounting rod to enable use with the optics benches
- 2x Spectrometer Prism (EDF)
- Experimental guide suggesting experiments that can be performed

F4L87359	set **£74.99**

B Clear Glass Prism

90° x 45° x 45°. Refractive index 1.52 approx. Polished faces.

	Hypotenuse x length	each
F4A45615	35 x 25mm	**£3.50**
F4A45627	70 x 50mm	**£9.15**

C Clear Glass Prism

60° x 60° x 60°. Refractive index 1.52 approx. Polished faces.

	Length	Face	each
F4A45585	25mm	25mm	**£3.25**
F4A45597	38mm	38mm	**£3.65**
F4A45603	63mm	63mm	**£21.99**

D Perspex Prism

60° x 60° x 60° Clear perspex, polished surfaces.

	Length	Face	each
F4A45640	63mm	38mm	**£3.70**
F4A45639	38mm	63mm	**£3.25**

E Perspex Prism

90° x 45° x 45° All faces fully polished.

	Hypotenuse x length	each
F4A45652	35 x 25mm	**£2.50**

F LED.white and Light Guide Demonstrator

The LED.white is a superb alternative to the traditional raybox. It can be used in most experiments in place of a ray box and offers a number of advantages:

- Purer white light compared to the traditional ray optics boxes
- No additional power supply required (5V plug top included)
- Uses less power (1W LED rather than 24/36W bulb) and is much cooler than traditional ray optics boxes
- Much longer life (approx. 100,000 hours) than filament bulbs and because of plug top PSU the voltage can not be 'accidentally' increased to blow the bulb
- Can be mounted on a retort stand using the incorporated boss

Contents: Experiment guide on CD, LED.white, Light guide demonstrator, power supply, slit plate and slit plate holder

The LED.white and Light Guide Demonstrator can also be bought separately.

F4R00001	kit **£85.50**

The LED.white and the Light Demonstrator are Available Individually.

Spares and Accessories

LED.white

Includes an experiment guide on CD.

F4L87348	kit **£59.99**

Spectrometer Prism; Extra Dense Flint

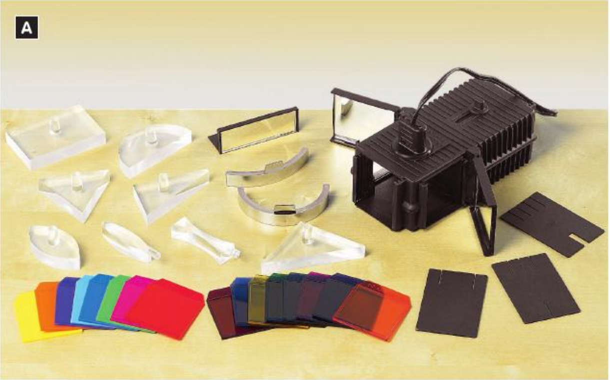
90° x 45° x 45°. Extra dense flint glass, refractive index 1.7 approx. 2 faces optically polished.

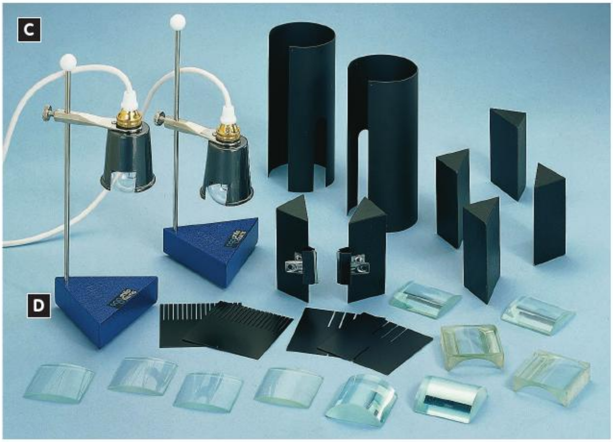
F4A46413	each **£12.85**

Light Guide Demonstrator

An acrylic bar 220 x 20 x 20mm, formed into a shallow 'S' shape.

F4A45688	each **£35.99**





Spares and Accessories

Light Box Only

The bare light box, with formers for a collimating lens and slit plates.

F4A44271 each **£66.99**

Low Voltage Bulbs

F4A56832 12V 36W each **£1.70**

Spare Halogen Bulb

F4R02149 12V, 20W. each **£3.25**

Set of Slit Plates

F4A44222 pair **£3.99**

A Light Box And Optical Set

A set of optical apparatus for all types of optical experiment involving reflection, refraction and colour mixing. The principal component is a robust light box finished in matt black with a 12V halogen lamp with 0.75m of twin flex. One end of the box has a cylindrical convex lens in an adjustable sliding mount which allows a parallel, convergent or divergent beam to be produced. The other end of the box has a triple aperture system for colour mixing experiments, the lateral apertures having adjustable hinged mirrors. All apertures in the box are provided with vertical channels to hold slit plates and/or colour filters.

Optical accessories included:

- Perspex blocks (prisms): One rectangular, one semi-circular, one triangular prism 60° x 60° x 60°, one triangular prism 90° x 60° x 30°, one triangular prism 90° x 45° x 45°
- Cylindrical perspex lenses: One double concave, one double convex (both with the same radius of curvature), one thick double convex
- Mirrors: One curved metallised plastic (parabolic), one curved metallised plastic (semi-circular), one plane glass (mounted on stand)
- Black plastic slit plates: One with three narrow slits and one narrow slit, one with four narrow slits and one wide slit
- Set of eight colour filters: Primary red, primary green, primary blue, cyan, violet, yellow, orange and magenta
- Set of eight coloured cards: Red, green, blue, violet, orange, cyan, yellow, pink

The set is supplied complete with a spare lamp and a detailed instruction manual.

Dimensions of light box: 170 x 90 x 55mm.

F4A44106 set **£55.99**

B Compact Light Source

A very efficient 12V 100W quartz iodine lamp in a ventilated metal housing. 19mm diameter apertures on two adjacent sides allow the lamp to be used either as an intense horizontal 'line' source, or end-on as a powerful 'point' source. The aperture not in use may be closed by a pivoted shutter. The lamphouse is mounted on a rod 160mm long x 10mm diameter for supporting from an ordinary laboratory stand.

Dimensions of lamphouse: 78 x 78 x 153mm.

Supplied with twin 4mm leads. (Power supply not included).

F4H76839 each **£124.99**

C Ray Optics Kit

A versatile kit of components for ray optics experiments. Investigations possible include linear propagation of light rays, focusing of rays by cylindrical lenses, focusing of multiple rays showing aberration, law of reflection, refraction in water, prisms, etc.

Contents:

- 2 lamps and stands
- 1 pair of housing shields
- 2 combined single and triple slit plates
- 2 multiple slit combs
- 2 holders for combs and slit plates
- 4 wooden light barriers
- 4 plano cylindrical lenses +7D
- 2 plano cylindrical lenses +10D
- 2 plano cylindrical lenses +17D
- 2 plano cylindrical lenses 17D

F4H25857 pack **£182.99**

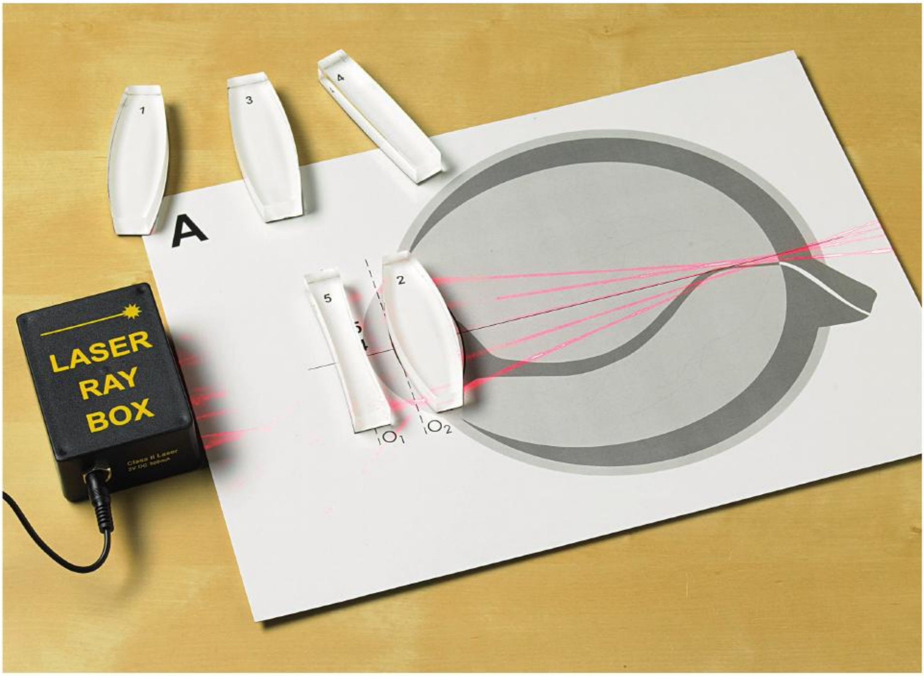
D Lamp and Stand

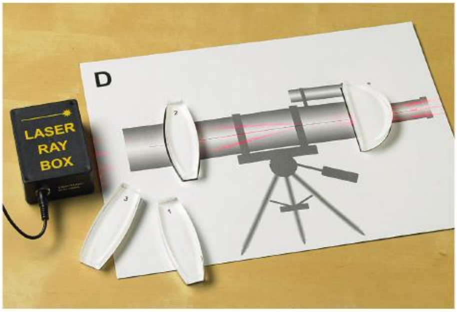
Comprising a 12V 24W lamp in a conical lamphouse mounted on an adjustable boss. The lamphouse has cut-outs in its side giving a clear passage for the light while restricting the amount of stray illumination. The assembly is supported on a rod with a triangular cast base.

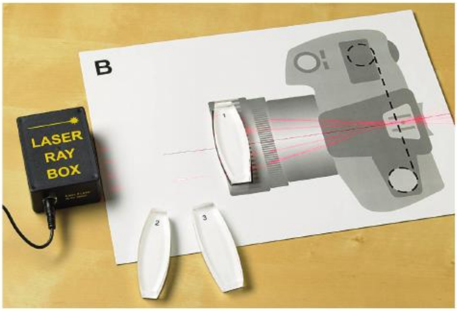
Triangular base: 100mm side x 28mm high.

Overall height of stand: 240mm. Supplied with lamp and lead with 4mm plugs.

F4H76828 each **£57.99**







Ray Optics with Laser Ray Box

An exciting way to learn about optics by building and exploring common optical systems.

The Laser Ray Box emits five red laser streaks across any flat surface it is placed on. The Ray Box is magnetic so it can stick to some whiteboards. This kit can be used in normal room lighting, or reduced light. Blackout is NOT necessary.

Add a work card (also magnetic) and you have the outline of an optical device. Choose from: an eye, a simple camera, a Galilean refracting telescope (opera glass), a modern refracting telescope, a wide angle lens and a large protractor for general work on reflection and refraction.

Outlines and numbers on each workcard guide students to choose suitable optical items (magnetic of course!) from the shaped storage case, to complete the optical device and reveal the path of light rays through the various components. Components can easily be moved and changed to explore the phenomena of long and short sight, see how spectacle lenses provide correction, understand how a camera or telescope creates a focused image, investigate refraction and calculate refractive indices.

All the optical items can be used individually for teacher-designed investigations.

Contents:

- Laser Ray Box and plugtop mains adaptor (5V)
- 6 laminated magnetic workcards, approx 400 x 280mm
- 6 acrylic lenses, 5 numbered for identification
- 3 mirrors: plane, convex and concave
- 2 semi-circular blocks/lenses
- 1 right angle prism
- 1 rectangular block
- 1 straight "light pipe"
- 5V plug top power supply for LED lines

Sizes: Optical items and Workcards 430 x 350 x 60mm, mass 1.72kg. Laser Ray Box 100 x 75 x 40mm, mass 250g.

F4R03098 kit **£219.99**

A LED.line

- Explore the action of colour filters
- Demonstrate diffraction at different wavelengths
- Calculate the wavelength for each LED colour
- Measure the voltage across each LED and determine Planck's Constant graphically

This visually appealing device clearly illustrates the relationship between colour and wavelength. Seven coloured LEDs plus white, span the visible spectrum. Mounted in a robust vertical column, the LEDs can easily be viewed by a whole class. Depending on the diffraction grating used, first, second and third order fringes can be observed and used for calculations. The LED.line has a rotary switch to allow users to select and measure the voltage across each individual LED. Knowing these voltages and the wavelength for each LED, Planck's Constant can be determined. Students have a great opportunity to consider and minimize the sources of error in their experimental work. Teacher's notes are included on CD. 5V Power supply included.

F4R03089 each **£67.99**

B Coloured Acetate

A4 sheets of acetate in red, yellow, green and blue. The sheets are easily cut to make filters for colour experiments. Pack of 20.

F4R05668 each **£17.99**

C Colour Paddles

For simple experiments in subtractive colour mixing. A set of six transparent acetate paddles, one each of yellow, red, blue, orange, green and magenta, in the form of a 'fan'. Dimensions L50 x W73mm.

F4A46012 each **£6.00**

Diffraction Grating

In 50 x 50mm mounts.

F4A46279	300 lines/mm	each **£13.25**
F4A46280	600 lines/mm	each **£16.25**

This superbright LED.mixer demonstrates the power of primary colours. Create any colour you can imagine and transform ordinary objects, with nothing more than light!

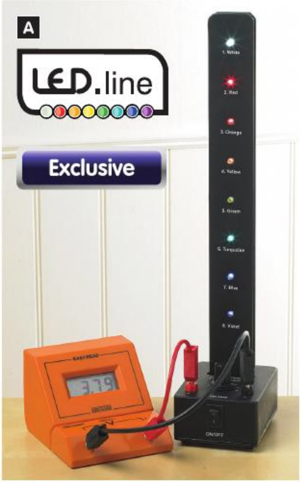
Using superbright LED technology, the LED. mixer makes it easier and cheaper than ever to deceive the eyes of your students, without the need for blackout. Featuring six mounted LEDs (two red, two green and two blue), and an interface giving precise button control over the intensity of each, the LED. mixer can create any colour visible to the eye. The demonstration is enhanced by the included circular aperture, creating circles of overlapping colour, and a translucent screen, so the effect is visible from two sides.

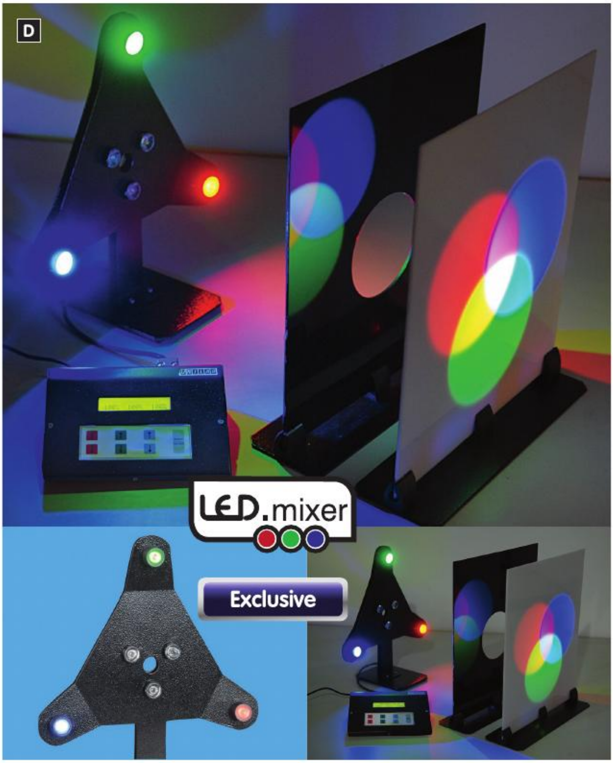
D LED.mixer with Power Supply

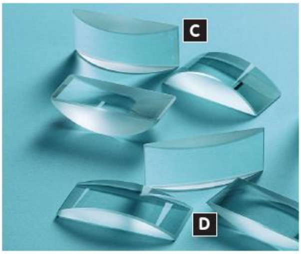
- Demonstrate primary and secondary colours
- Investigate colour perception
- Explore true additive colour mixing
- Easy to use alternative to the ray box and filters approach
- Ultra bright LEDs remove the need for full black-out

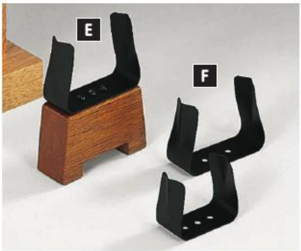
An eye catching demonstration of the fascinating phenomenon of colour mixing. A simple control box allows users to vary the brightness of six large LEDs (red, green and blue) which are mounted in a robust stand. The kit includes a translucent white Perspex screen and black aperture screen to demonstrate additive colour mixing. Exploring the effect of coloured light on a variety of coloured objects provides entertainment and sound learning. Full instructions supplied on CD.

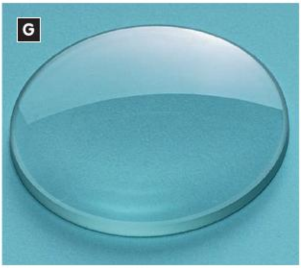
F4R03090 kit **£167.99**











A Unmounted Plane Mirrors, Glass

Back silvered with protective coating.

	Size	pack 10
F4A44556	75 x 25mm	**£1.10**
F4A44579	100 x 75mm	**£2.60**
F4A44581	150 x 50mm	**£2.30**

B Mounted Plane Mirror, Glass

Silvered back with protective coating, mounted on wooden block 20mm thick approximately.

Direct Delivery – up to 10 days

	Size	each
F4A44611	75 x 25mm	**£6.35**
F4A44623	100 x 75mm	**£7.99**

C Plano-Cylindrical Lenses

Clear glass with ground ends and optically worked faces. 50 x 50mm. Suitable for use with ray optics kit.

	Power, dioptres	pack 5
F4L27297	+ 7	**£16.99**
F4L27303	+10	**£17.99**

D Half-Size Plano-Cylindrical Lenses

Plano-cylindrical lenses, clear glass with ground edges and optically worked faces, 50 x 22mm high. Suitable for use with ray optics kit.

All experiments carried out with full height lenses may be performed with half-size lenses.

	Power, dioptres	pack 5
F4L27339	+7	**£9.99**
F4L27340	+10	**£13.25**

E Lens Holder, Mounted

Designed to hold lenses or mirrors of 50mm diameter. Comprises a strip metal spring clip with a locating 'V' in either side arm, mounted on a stand with a groove across the base to accommodate a metre rule.

F4H25959 each **£3.30**

F Lens Holder, Unmounted

Comprising a metal holder with sides grooved to hold the lens or mirror. The holder is finished in matt black and is free standing for bench use. Designed to hold lenses or mirrors of 50mm diameter.

F4H25948 each **£2.99**

G Plano Convex Lenses

Optically worked faces; ground edges; refractive index: 1.52.

	Focal length	Diameter	Power	pack 5
F4L27273	140mm	50mm	+7D	**£5.99**

H Spherical, Double Concave Lenses

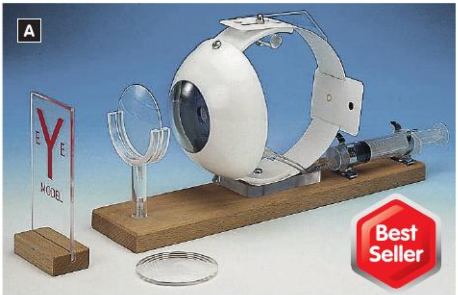
Optically worked faces; ground edges; refractive index: 1.52.

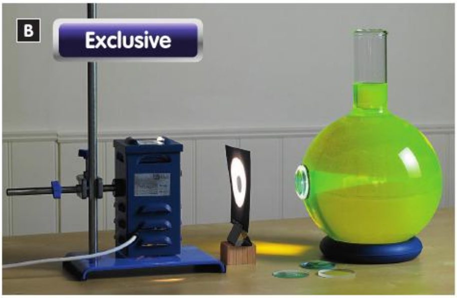
	Focal length	Diameter	Power	pack 5
F4L27236	50mm	50mm	-20D	**£6.75**
F4L27248	100mm	50mm	-10D	**£5.99**
F4L27259	150mm	50mm	-6.6D	**£5.99**
F4L27261	200mm	50mm	-5D	**£5.99**

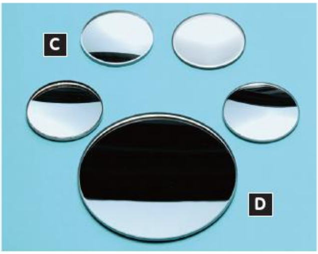
I Spherical, Double Convex Lenses

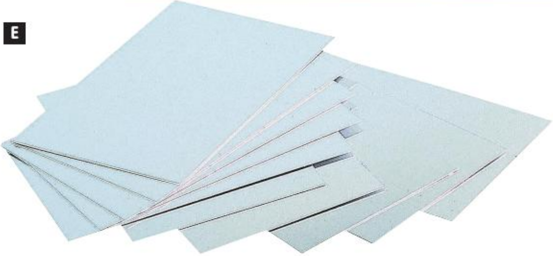
Optically worked faces; ground edges; refractive index: 1.52.

	Focal length	Diameter	Power	pack 5
F4L27108	50mm	38mm	+20D	**£6.60**
F4L27145	50mm	50mm	+20D	**£6.10**
F4L27157	100mm	50mm	+10D	**£5.99**
F4L27169	150mm	50mm	+6.6D	**£5.99**
F4L27170	200mm	50mm	+5D	**£5.99**
F4L27194	300mm	50mm	+3.3D	**£5.99**
F4L27200	500mm	50mm	+2D	**£5.99**









Helpful Hint

FLUORESCENCE

To give the required fluorescence, only a very small quantity of fluorescein should be added to the water in the flask. The model eye can also be used with a laser source, which helps students to compare and understand the classic ray diagrams of the eye, using this large scale model.

A Functional Eye Model

This unique model permits demonstration of the physical principles upon which the eye operates, including defects of vision and their correction.

The lens and ciliary body are flexible, the lens itself being fluid filled and connected to a syringe. The syringe can be used to vary the pressure in the lens and hence its thickness, to simulate accommodation. The length of the 'eyeball' may be varied to simulate long or short sight and a lens support mounted in front of the 'cornea' allows external lenses to be used to demonstrate correction via spectacles. A major advantage of this model is that actual images may be projected onto the 'retina', making it an extremely effective demonstration tool.

The complete model is mounted on a wooden base, and has overall dimensions of L320 x H180mm.

F4A45755 each **£344.99**

B Model Eye Kit

Demonstration kit comprising a 5 litre round bottom glass flask complete with a rubber ring stand, 450g of plastic modelling clay and one each of the following 50mm diameter meniscus lenses +11D, +8D, +5.5D, +2.5D, -3D. The first three lenses are fixed to the flask with plastic modelling clay to show short, normal and long sight respectively when a beam of light is passed through them. The other two lenses are used for correcting the long and short sighted condition. The flask is filled with water with a little fluorescein (sold separately) added in order to show the path of light through the model eye.

Suitable light sources include: Compact Light source, or LED.white. Customers will need to purchase Fluorescein sodium salt separately.

F4A45731 kit **£96.99**

E Convex Glass Mirrors

Optically worked, silvered back with protective coating.

	Diameter	Focus	pack 5
F4L27558	50mm	100mm	**£7.30**
F4L27569	50mm	200mm	**£7.10**
F4R05109	100mm	1000mm	**£14.99**

F Concave Mirrors, Glass

Optically worked, silvered back with protective coating.

	Diameter	Focus	pack 5
F4L27066	50mm	100mm	**£7.30**
F4L27089	50mm	200mm	**£7.20**

Double-Sided Mirrors

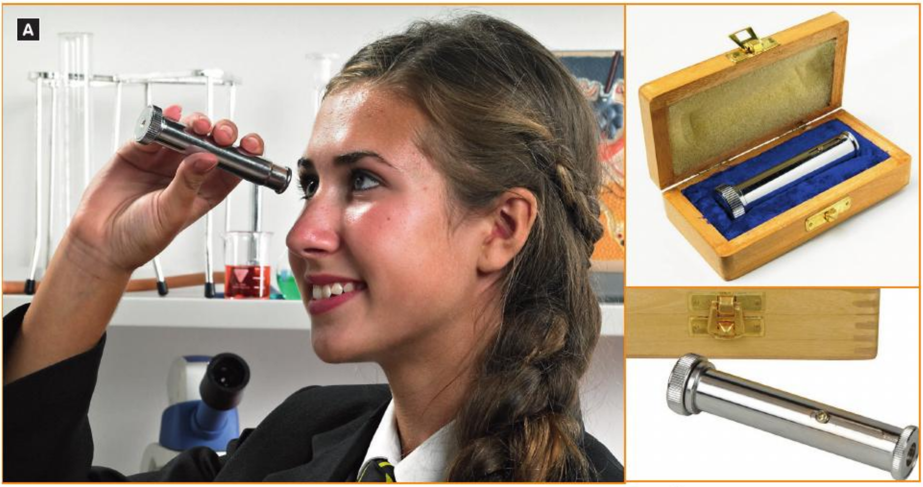
Flexible metallised plastic double-sided plane mirrors. Whilst being very strong, the mirrors may be easily subdivided with a sharp knife. Thickness 0.75mm.

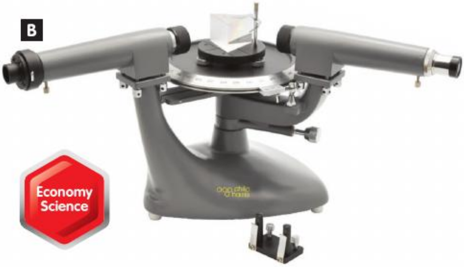
F4A44439 150 x 100mm pack 10 **£8.99**

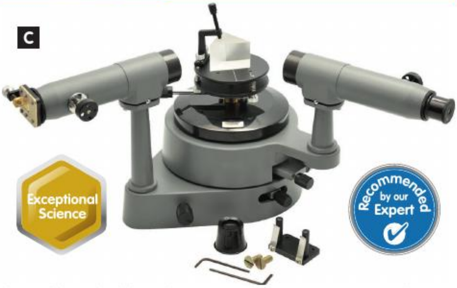
Concave/Convex Double-Sided Mirrors

Flexible metallised plastic double-sided concave/convex mirrors. Whilst being very strong, the mirrors may be easily subdivided with a sharp knife. 100 x 100mm. Thickness 0.75mm.

F4A44453 100 x 100mm pack 10 **£4.60**







A Pocket Diffraction Spectroscope

For examination of the spectral composition of light sources, radiant bodies, etc. The instrument gives a brilliant spectrum with a dispersion of approximately 11°. The slit is of fixed width and is protected by a glass cover plate. The eyepiece is mounted at the end of a draw tube and is adjustable in relation to the slit so that a sharply defined spectrum can be obtained. Both sodium D lines are independently resolved (589nm and 589.6nm) and the Fraunhofer lines are visible. Supplied in a carrying case.

Size: 80 x 19mm, length x diameter.

F4A81802 each **£39.50**

B Harris Standard Spectrometer Vernier

An economically priced, high-quality, precision manufactured instrument capable of quantitative work. The main structural parts of this laboratory grade spectrometer, including the collimator and telescope bodies are manufactured from heavy castings for durability and precision. This lab-quality spectrometer offers excellent quality at a price that every classroom can afford. The collimator consists of an adjustable slit on one end, with an achromatic converging lens (focal length 178mm) on the other. The lens is secured in a tube which can be adjusted by hand to ensure the slit is in the focal plane of the lens, thus producing parallel rays. Scale: 170mm diameter, 0 to 360deg x 1deg, capable of independent rotatation, with locking screw. A spring-loaded vernier scale (attached to the telescope mount) provides readings to 0.1 deg (6 minutes of arc). Collimator mounted on fixed pillar with axis adjustment. The collimator is mounted on a spring loaded support, integral with the base. The prism table is mounted on a 175mm diameter circular degree scale. The scale is rotatable around the central axis and is provided with a clamping screw. Prism table is provided with three levelling screws and has lines marked to assist with precise placement of prism. The astronomical type telescope consists of an achromatic objective at one end, and a Ramsden's eyepiece with cross wires. The position of the lens can be adjusted by hand. The telescope is mounted on heavy bearings, and can be rotated around the central axis of the apparatus. A clamping screw allows fixing of the telescope position, and a tangent screw allows fine movement. A vernier scale allows the position of the telescope to be read to a precision of 0.1°. Spectrometer is supplied in a durable thermocole box and includes working instructions. Dimensions: 16.5 x 12.2 x 11 inches. Weight: 10.9 pounds. Standard Accessories: 1 prism clamp for prisms up to 40mm high, 1 diffraction grating holder aperture 25 x 25mm, 1 small screwdriver and 1 tommy bar for axis adjustment.

F4R05957 each **£331.99**

C Advanced Spectrometer

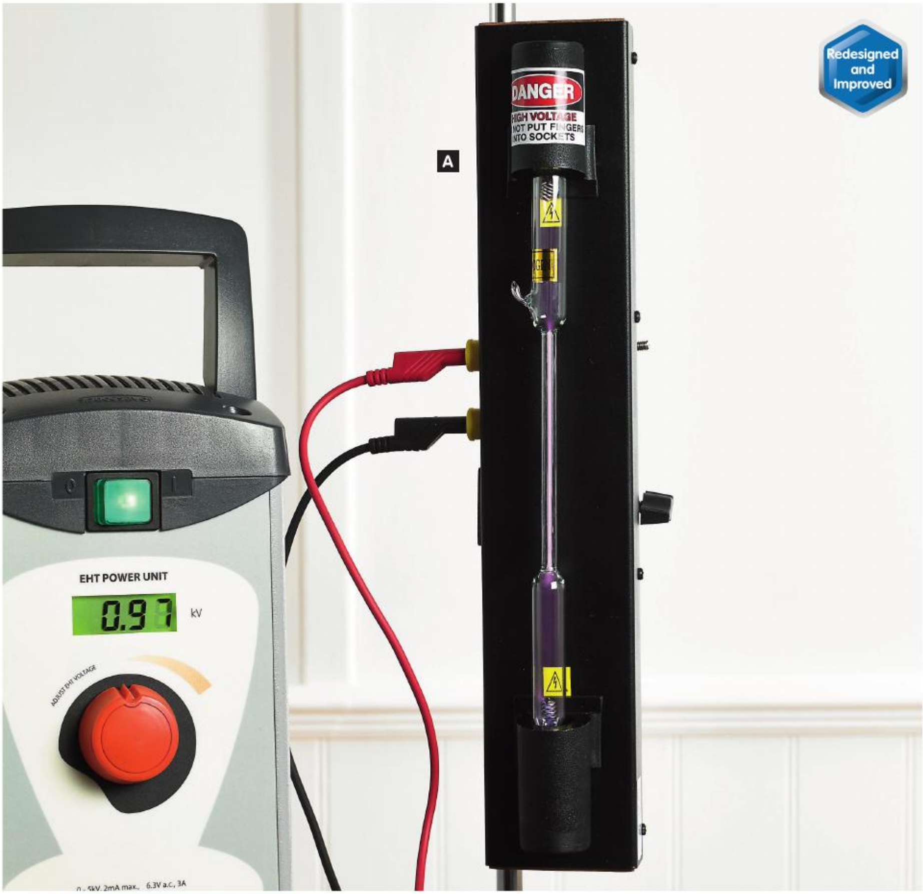
- Scale: The 177mm diameter circle is fixed, and the table and telescope movements are completely independent of each other. Both movements can be read to 30 seconds of arc by means of double ended verniers. Both rotations have fine adjustment screws, and release of a clamping screw enables coarse adjustment to be made by hand.
- Collimator: Mounted on fixed pillar and fitted with 178mm focus achromatic objective, 32mm clear aperture. A unilaterally adjustable slit, 6mm long is also fitted.
- Telescope: Mounted on moveable pillar and fitted with 178mm focus achromatic objective, 32mm clear aperture. Also fitted is a x15 Ramsden eyepiece and a glass crossline graticule. Both the telescope and collimator have rack and pinion focusing.
- Prism Table: The table is marked with lines to assist placing the prism with respect to the table levelling screws, and has interchangeable clamping units for the prism and a diffraction grating.

Standard accessories supplied:

- 1 dense flint glass prism
- 1 prism clamp
- 1 diffraction grating holder
- 1 watchmaker's eyeglass
- 1 tommy bar for adjusting optical axes
- 1 polished hardwood case
- 177mm diameter circle

Allows readings to 30 seconds of arc.

F4A46395 each **£1499.99**



Laboratory Discharge Lamps

Comprising a lamphouse and transformer and a range of spectral lamps available separately. The lamps give a steady light output of high intensity, and the special design of transformer ensures that the lamps 'strike' immediately they are switched on. When mounted on the integral stand, the lamp is enclosed by a cylindrical metal lamphouse with a circular aperture and the light centre height is adjustable from 200mm upwards.

A Spectrum Tube Holder

This economical special holder allows an external power source to be used for 26cm long spectrum tubes. Fitted with 4mm safety sockets on black panel. This holder is fitted with bosshead which allows its clamping on any laboratory stand. Stand is not included.

F4R06039 each **£42.99**

B Spectrum Tubes

Gas-filled discharge tube for studying typical spectra of the different gases and for use in calibrating spectrometers. The glass body is provided with metal end caps and is constricted along the middle portion to concentrate the discharge glow. Maximum recommended running current 3mA.

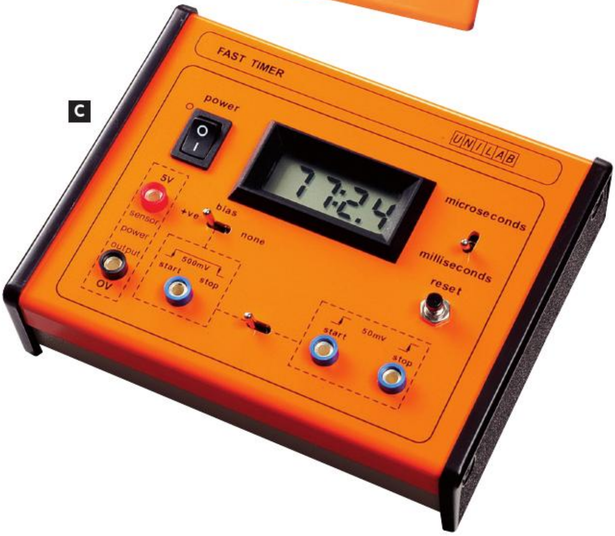
F4A46539	Hydrogen	each **£16.99**
F4A46541	Nitrogen	each **£16.99**
F4A46553	Oxygen	each **£16.99**
F4A46565	Neon	each **£16.99**

A

B

CENTI-SECOND TIMER MODULE
Clock controlled by input A
Clock controlled by inputs A and B
UNILAB
A
0V
B

C



A Unilab Digital Stopclock

- Large 12mm high display
- Timing features include start/stop and reset via the top-mounted push switches or via the front panel 4mm sockets

The stopclock can time up to 1 hour in 1/100 second with split (lap) timing if required. It is powered by two AA/R6 or HP7 cells which give many months of use. If light gates are to be used, the Centisecond Timer Module provides extra facilities.

Please note this product is not supplied with a battery.

F4H27507 each **£43.99**

B Centi-Second Timer Module

An accessory module which plugs into the front of the Stopclock and allows Light Gates to control the timing in either of two ways. In mode A, the clock measures between successive changes on one input (minimum time of 0.12s). This can be used to time the interruption of the light beam by a vehicle of known length. In Mode B, the clock times between successive changes on either input, so that the time between two Light Gates can be measured. Battery not included.

F4H27749 each **£37.50**

C Fast Timer

The Fast Timer is a versatile, portable instrument for timing brief events with two ranges: 1 to 999.9ms and 1 to 9999µs. The inputs can be controlled by light gates, microphones or mechanical switches, connected via 4mm sockets. Two sockets provide 0 and 5V for connection to sensors if required.

The usual care is needed when using microphones to ensure that a repeatable sharp edge is obtained, e.g. use a toffee hammer and steel slab to produce a sharp noise when measuring the speed of sound.

Mass: 0.5kg.

Size: 170 x 135 x 45mm.

F4H28573 each **£192.99**

CROSS REFERENCE

If you want to use the Fast Timer for measuring the speed of sound, a complete kit is available. See the Speed of Sound kit on page 55.

The Light Gate on page 78 can also be used with the Fast Timer.

Spares and Accessories

Button Cell

Silver oxide button cell type LR44.

F4A54161 1.5V each **£1.99**

A Ticker Timer

This extremely popular unit has revolutionised experiments because of the quality of the traces it makes, and the reliability of the mechanism ensures that ticker-tape experiments are no longer hit and miss.

There is no double-dotting or smearing, even at high speeds. No pen or carbon discs are required. Friction between tape and ticker-timer is kept to a minimum. Excellent results can be expected. The unit comes with a boss-head so that it can be easily clamped in a rod. Requires 2V AC from a low-voltage power supply. The unit is protected by a 2A internal fuse. Uses self-marking paper tape. Self marking tape is not included.

F4R06037 each **£54.95**

B Paper Tape Holder and Baseplate

Stand with 10mm statinless steel mounted rod to hold tape rolls. A specially designed stand to hold our ticket tape rolls, with easy possible, it is an excellent accessory. Paper not included.

F4R05960 each **£53.99**

Spare Paper Tape

Self marking spare paper tape for item A, 300m reel.

F4A41890 each **£5.99**

C Ticker Tape-Timer

For the measurement of velocity and acceleration, using timing marks made on a moving paper tape by a vibrating 'striker'. Designed to operate on a 12V a.c. supply and uses the mains frequency as its timing standard. The unit is housed in a moulded case L115 x W60 x H70mm, including mounting flanges. The top of the case carries a tape guide with carbon paper disc support and adjustable 'anvil' for the striker point.

All moving parts are fully enclosed and electrical connection is via 4mm sockets.

F4H31055 each **£56.99**

D g by Free Fall Apparatus

To determine the value of 'g' by timing the fall of a steel ball. The release unit consists of a plate 90 x 45 x 3mm carrying a pair of metal clips connected to 4mm sockets. The clips are opened, thus dropping the ball and breaking the contact between the clips.

The trip unit is mounted on a base measuring 100 x 100 x 12mm and comprises of a trip plate, the end of which bears upon the blade of a micro switch and holds it in the closed position. When deflected downwards by the impact of the ball the trip plate releases the blade and opens the switch. The trip plate comes complete with a protective rubber strip to prevent the switch from damage should it be accidentally struck directly by the ball.

Kit comes complete with steel balls of 16mm and 19mm diameter.

F4H25316 each **£99.99**

E Pendulum Clamp

This sturdy pendulum clamp is constructed of an aluminium support bar with three screw clamps, attached to a die cast head clamp for use on support rods to hang weights and pendulums. Can attach to support rods up to 16mm in diameter.

Three screw clamps can securely and individually be used to attach weights with strings. This pendulum clamp makes it easy to simultaneously demonstrate or test the properties of simple harmonic motion in physics labs or classrooms. Size: 29 x 3 x 3cm.

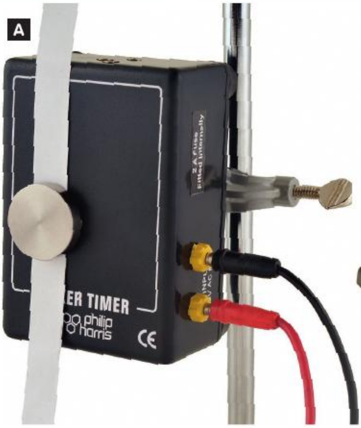
F4R05975 each **£9.99**

F Pendulum Bobs Pack

Comprising one solid sphere each of diameter 13mm, 19mm, and 25mm, of brass, copper, iron, lead and aluminium with a small ring for suspension.

F4R05990 pack 15 **£17.99**

A



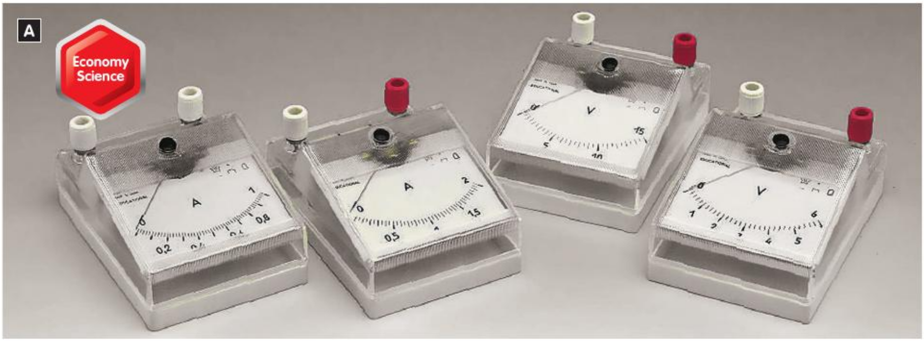
B

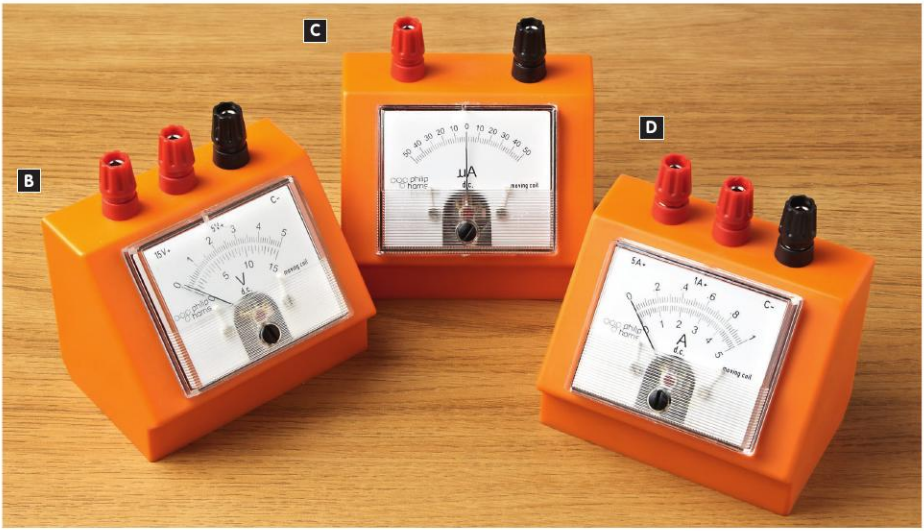
C

D

E

F





A Economy Bench Meters

Moving coil, centre pole movements in clear plastic case. Captive 4mm socket terminals, 4% accuracy, d.c. only.

	Range	
F4A74445	0 to 1A	each **£8.30**
F4A74457	0 to 2A	each **£8.30**
F4A74469	0 to 6V	each **£8.30**
F4A74470	0 to 15V	each **£7.30**

B Voltmeter, Dual Range

A moving coil voltmeter, suitable only for d.c. voltages. Sensitivity 1000Ω/V nominal. Ranges 5V and 15V.

F4A74640 each **£42.99**

C Galvanometer 1000Ω

A centre zero galvanometer 50µA - 0 - 50µA graduated every 2µA.
The resistance of the meter is about 1000Ω.

F4A74729 each **£29.99**

D Ammeter, Dual Range

This moving coil meter has two ranges, 0 to 1A or 0 to 5A and is suitable for d.c. only. Volts drop 75mV.

F4A74597 each **£42.99**

VISIT OUR WEBSITE FOR MORE RESOURCES AND IDEAS
www.unilab.co.uk

Helpful Hint

DEMONSTRATION IDEAS

Scientists measure energy in joules (J), but electrical equipment is usually rated in watts (W) or kilowatts (kW). The connection is quite straightforward, the meter unit tells you the power (in watts) which is how quickly an appliance is using energy.

A 60 watt lamp uses 60 joules per second, a 2 kilowatt heater uses 2000 joules per second. If your TV is rated at 200 watts, it uses 200 joules per second. When you pay an electricity bill, you are charged for units called kilowatt-hours (kWh).

A Basic Motion Measurement Kit

The basic kit for Motion Measurement uses the Digital Stopclock as the timing device. The kit contains a Stopclock, centisecond Timer Module and two Light Gates. Minimum time interval 0.12s. Recommended for use with Bench Power Supply. Batteries available on page 100 - Duracell "Procell" AA and Button Cell, Silver Oxide, type SR44.

F4H76798 kit **£205.99**

B Advanced Motion Measurement Kit

Based on our exclusive Motion QED unit the kit contains: one Motion QED unit, one Master Light Gate and one Slave Light Gate. Up to eight transitions of the light gates can be sensed and the times stored by the Motion QED unit.

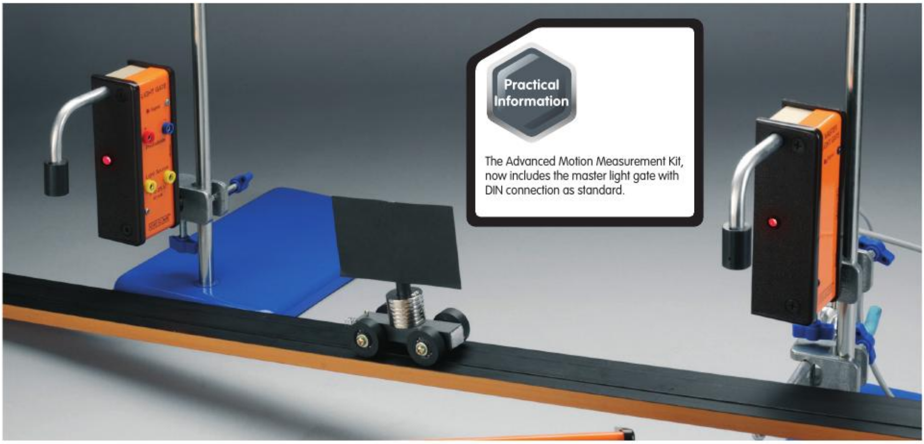
F4H76786 kit **£369.99**

Helpful Hint

The Unilab Motion Measurement kits are simple to use and highly accurate. They offer an excellent foundation for collecting data and using this for speed calculations.

A

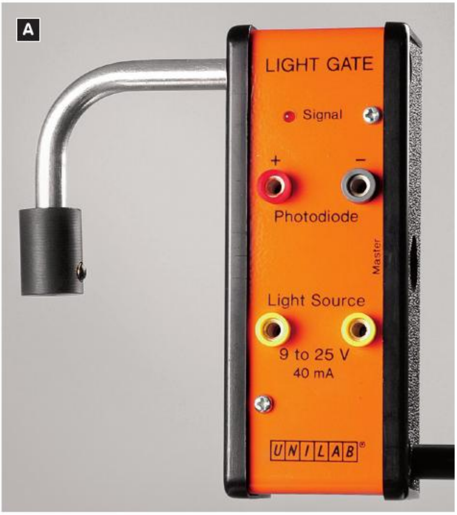
B



Practical Information

The Advanced Motion Measurement Kit, now includes the master light gate with DIN connection as standard.

A



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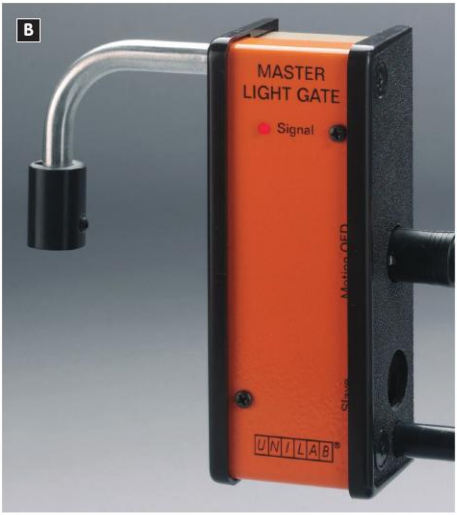


Light Gate using 4mm plug leads

Spares and Accessories

5-Pin DIN plug lead

A 5-pin 180° DIN plug to plug lead. Connected pin 1:1, 2:2, 3:3 etc. Pure copper conductors. Length: 1.5m.

F4R06095 each **£1.99**

A Light Gate

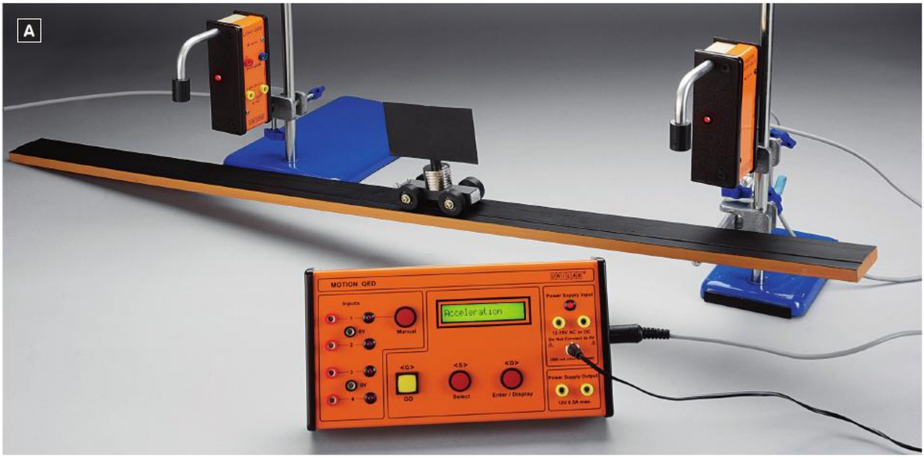
Our popular UNILAB Light Gate is fully protected against incorrect connection of signal or power and supplies from 9 to 25V a.c or d.c. can be used. A signal LED indicates that the unit is functioning correctly when obstructed. The unit is compatible with all of our timing devices such as: Motion QED, Fast timer, Centi-Second Timer Module and Stopclock and Scaler-Timer.

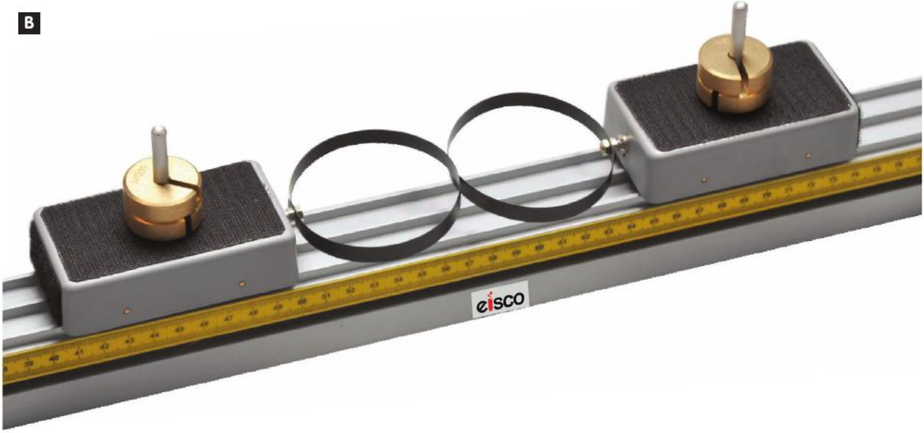
F4H27623 each **£57.30**

B Master Light Gate With Leads

For connection to Motion QED only. As above except both power and signal are carried by a single DIN lead. A further DIN lead connects the master light gate to a slave light gate. The 2 DIN leads included in the kit replace the need for eight 4mm leads, carrying both signal and power.

F4L86356 each **£98.99**





A Unilab Motion QED

Motion QED is a popular self-contained unit designed to store and calculate times, speeds and accelerations.

Specification:

Event Timer: From 2 to 8 readings, timing each event.

Interval Timing: From 1 to 4 readings: up to 4 successive obstructions on any combination of the four inputs can be measured and displayed.

Speed: From 1 to 4 readings: speeds (in meters per second, display shows m/s) are calculated and displayed for mask lengths of 1 to 10cm (in 1cm steps) or from 10 to 200cm (in 10cm steps).

Gap Timer: From 1 to 3 readings: similar to Interval Timing with only the leading edge of an obstruction being recognised so that times between gates are recorded and displayed.

Average Speed: 1 reading: based on the Gap Timing Mode above, this program calculates and displays an average speed (in m/s) between gates which are from 10 to 200cm apart (in 10cm steps).

Acceleration: 1 or 2 readings: for a vehicle carrying a single or double mask of known length passing through successive gates, the acceleration is calculated and displayed (as m/s/s).

A useful feature of Motion QED is the ability to measure times which students then use to calculate speeds or accelerations. Once the theoretical groundwork has been done, the unit can be used to perform the calculations directly, allowing students to concentrate on the physics.

Technical Details:

Inputs: 4 TTL inputs protected against misconnection up to 20V a.c. or d.c.; 4mm sockets with 1 "Manual" push-button.

Outputs: 12V to power external devices such as light gates; 4mm sockets

Power: 12 to 16V a.c. or d.c. from a low voltage power supply.

Protection: two internal 500mA anti-surge fuses.

Timing: times to ±1ms.

Mass: 0.9kg.

Size: 240 x 135 x 45mm.

F4H28020	each **£299.99**

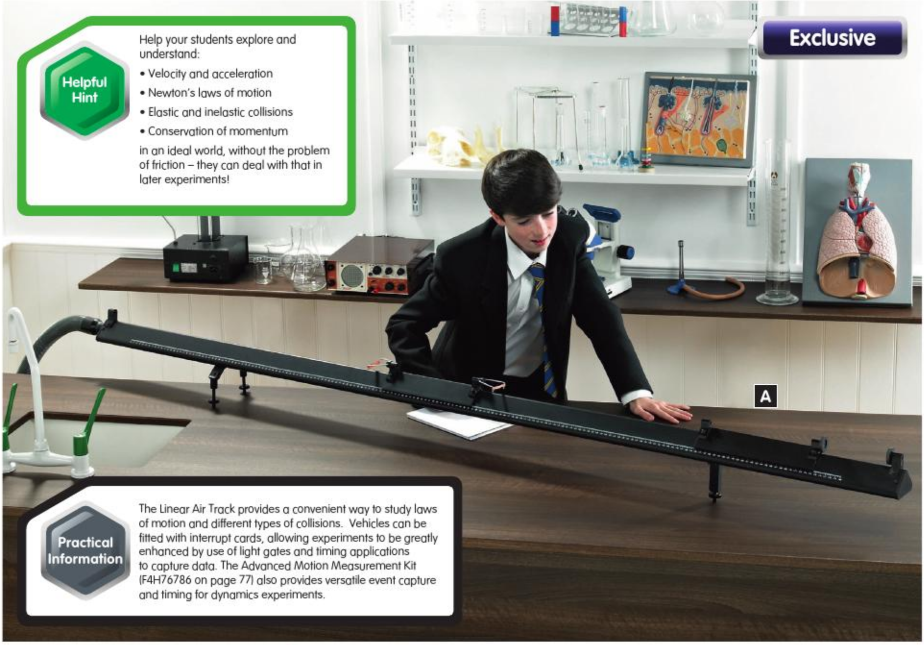
B Collisions Kit

A simple and easy to use kit for work on momentum collisions and the coefficient of restitution as well as conservation of energy. The kit consists two bogies having one side with Velcro® pad and other side with spring. Track 1.2m long graduated, pair of support feet, 2 photogate support holders and rods, masses set of 50g, 20g and 10g each.

F4H30774	kit **£53.99**

CROSS REFERENCE

See our Power Supplies on pages 5-12.



Helpful Hint

Help your students explore and understand:

- Velocity and acceleration
- Newton's laws of motion
- Elastic and inelastic collisions
- Conservation of momentum

in an ideal world, without the problem of friction – they can deal with that in later experiments!

Practical Information

The Linear Air Track provides a convenient way to study laws of motion and different types of collisions. Vehicles can be fitted with interrupt cards, allowing experiments to be greatly enhanced by use of light gates and timing applications to capture data. The Advanced Motion Measurement Kit (F4H76786 on page 77) also provides versatile event capture and timing for dynamics experiments.

Spares and Accessories

Linear Air Track Accessories

F4L35051	pack **£82.99**

A Linear Air Track Kit (with Accessories)

Designed for the study of linear motion under virtually frictionless conditions, the Linear Air Track Kit is supplied complete with a range of vehicles and accessories in one integrated package. The concepts of velocity, acceleration can be explored and measured in the absence of friction, and work can be extended to cover conservation of momentum: elastic and inelastic collisions.

The Linear Air Track itself is made from strong, triangular section aluminum. Two rows of fine holes run along the faces of the track through which jets of air emerge to form an air cushion on which the vehicles float under virtually frictionless conditions. The track is supported on three adjustable feet. An air inlet tube is fitted at one end and the air pressure inside the track may be adjusted by the variable control on the Air Track Blower.

The kit includes the Air Track plus the following accessories:

- Track: right triangular section aluminum 60 x 60 x 80mm, overall length 2m
- Nominal height of centre line above bench: 120mm
- Vehicles: two 400g, 250mm x 50 x 5.5mm; one 200g, 230mm x 50 x 2.5mm, their masses are in the ratio 2:1
- Three spring buffers for attachment to the track ends or to vehicles for elastic collisions
- Three 'horns' used with rubber bands for elastic collisions
- Ten spare rubber bands
- Two Magnadur magnets and two counterweights
- A pair of Velcro® buffers for inelastic collisions
- Three black interrupter cards to fit the vehicles for use in timing

F4H25339	each **£239.99**

B Electric Blower for Linear Air Track

This air blower incorporates continuously variable air velocity control, and has been designed and developed to provide a superior alternative to modified vacuum cleaners. It has many applications and is particularly recommended for use with the Philip Harris Linear Air Track.

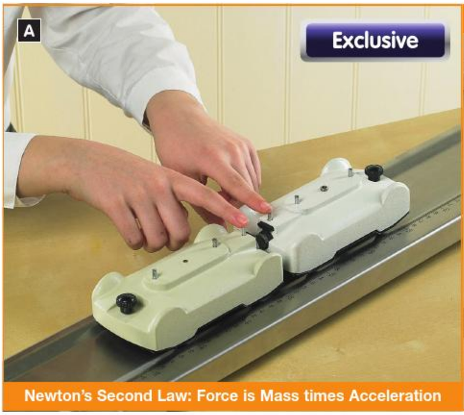
The air blower is supplied complete with hose, hose adaptor and an IEC mains lead with fitted safety plug. For 240V a.c. mains supplies.

F4H25341	each **£187.40**

PRICE MATCH PROMISE

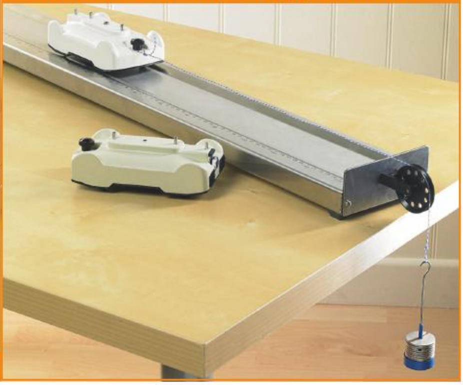
Find the same item cheaper and we'll match the price!

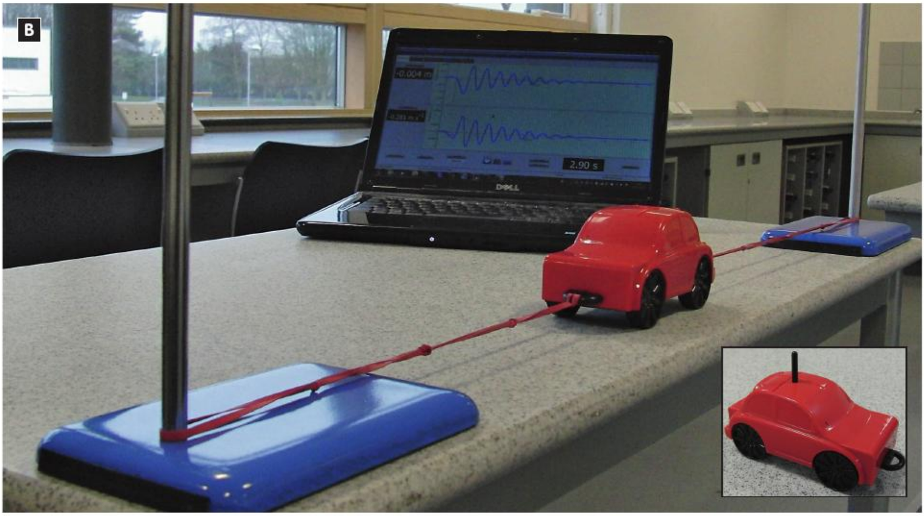
See Terms and Conditions



Newton's Second Law: Force is Mass times Acceleration

Newton's Third Law: Equal and Opposite Reaction





A Dynamics Track and Trolleys

A convenient alternative to the linear air track and blower. A sturdy and near frictionless stainless steel track that provides a compact environment for many investigations that might be done using a linear air track. Two heavy trolleys with hard, free-running wheels, are included, plus a set of 100g x 10g masses and a reel of cord. The track has solid end panels, with a rubber coating to buffer any collisions. A cm scale is screen-printed along the length of the track.

Each trolley has a knob for attachment of cords for towing, and for ticker tape if that is the school's preferred method of capturing the motion of the trolleys. A 4mm socket on the trolley's top surface, allows for simple attachment of interrupter cards for use with light gates or timing software.

A free-running pulley on one end of the track, allows a mass attached to a length of cord to be used as the accelerating force for one or two trolleys. Note that the trolleys can be stacked to immediately provide a trolley effectively of double the mass.

Each trolley has a spring-loaded ram that can be set and released to provide reliable and repeatable launches. The ram can launch a trolley (single or double mass) from one end of the track, or simulate an "explosion" where two trolleys fly apart.

The "Notes For Use" includes work on acceleration, exploring F=ma, investigations on an inclined plane, momentum and "explosions".

Track: 1270 (inc pulley) x 120 x 60mm, Mass: 3.1kg

Trolley: 155 x 76 x 55mm, Mass: 0.65kg

F4R03093	kit **£197.99**

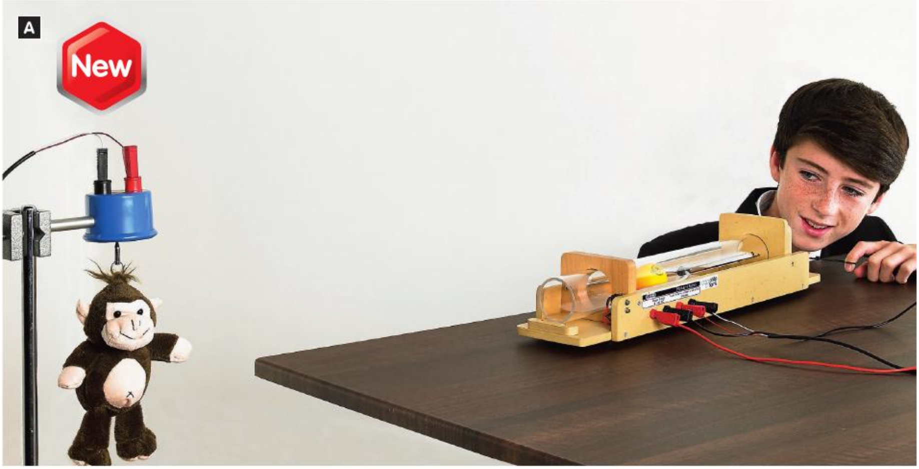
B DynaKar

The DynaKar is a unique product that simplifies dynamics investigations in Science, eliminating the need for lightgates and trolleys. The DynaKar communicates with the computer via a wireless device to create distance and velocity graphs. The DynaKar is extremely versatile and can be rolled along a simple ramp, or accessories and masses can be easily attached for collision and air resistance investigations.

- Easy setup with no drivers required
- Wireless communication to the computer
- 100 samples per second
- Resolution better than 1mm
- Powered by 2 x AA batteries

F4R04953	each **£114.99**

A



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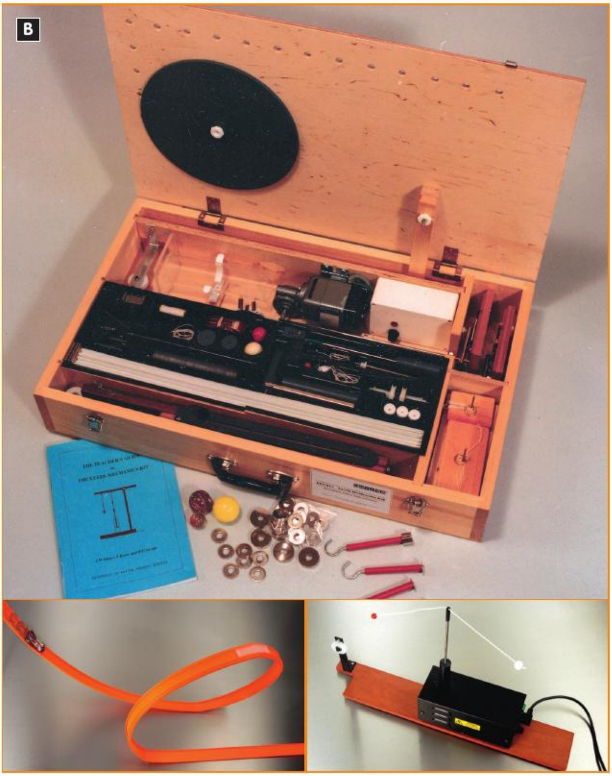

A Monkey and Hunter Launcher

This demonstrates the equation of motion and projectile theory. This apparatus allows for an interactive study of the problem by students. A spring powered "rifle" fires ping pong ball "bullets" at a model monkey supported from a small electromagnet. The electromagnet is switched off at the instant the projectile leaves the gun. No matter what the distance is between gun and monkey, the ball will always hit its target giving a dramatic demonstration of the fact that any projectile falls at the same rate regardless of its horizontal velocity.

F4R06045	set **£69.99**

B Leeds Mechanics Kit

- A complete kit for post 16 investigations in linear and rotational mechanics
- Inclined plane and friction experiments
- Circular motion and conical pendulum experiments
- Springs and damping experiments

The Leeds Mechanics Kit is a complete set of simple apparatus for practical investigations in Newtonian Mechanics that develops problem-solving and mathematical modelling skills. Areas covered by the kit are: Combining and Resolving Forces, Friction, Impact and Momentum, Motion in a Circle (horizontal and vertical, including the conical pendulum), Simple Harmonic Motion (with and without damping). Equipment is supplied in a sturdy wooden storage box, which also acts as a vertical force table.

F4H30580	kit **£724.99**

TO ORDER

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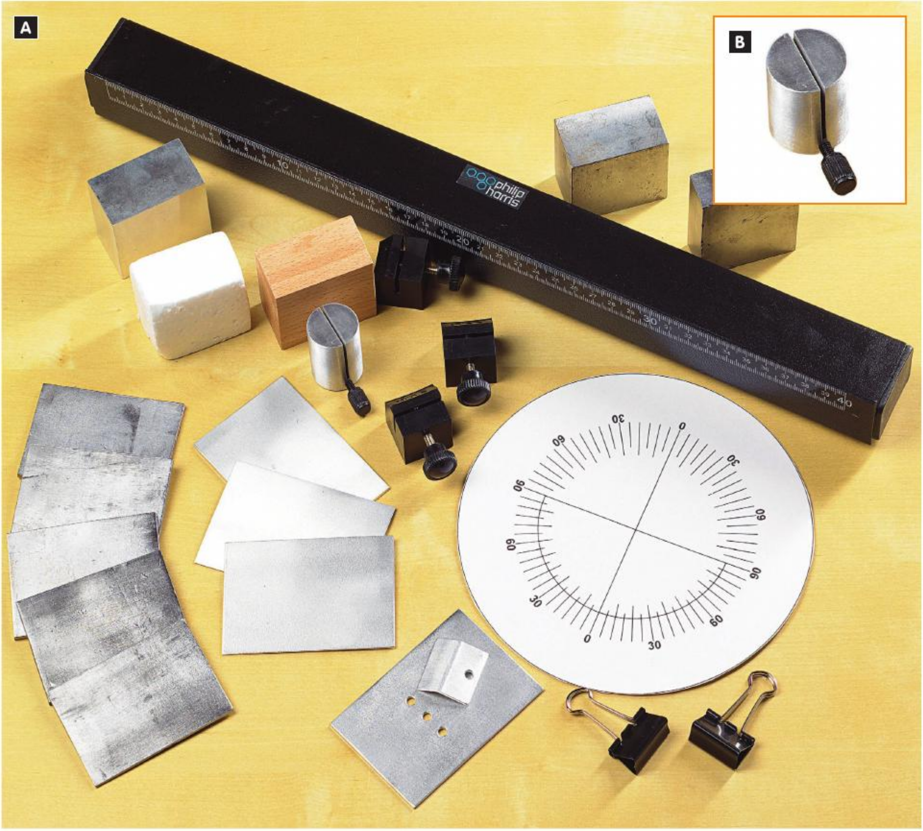


Teachers are always being encouraged to use practical work to develop students' skills in a way that helps understanding of theory and brings the subject alive in the classroom.

Physics is a practical science. Practical activities are not just motivational and fun: they can also sharpen students' powers of observation, stimulate questions, and help develop new understanding and vocabulary.

Good quality, appropriate physics experiments and investigations are the key to enhanced learning, and clarification and consolidation of theory.

This investigation into radioactivity (applicable to AQA Physics P2.5) will enable your students to understand:

- **The structure of an atom**
- **The randomness of radioactive decay**
- **What half-life means in this situation**
- **What alpha (α), beta (β) and gamma (γ) radiation are and their application in the world around them**

A Experimental Radioactivity Set

This set enables a comprehensive range of experimental investigations into the characteristics and properties of radioactive emission to be carried out.

The kit consists of the following items:

- Radioactivity bench with accessories
- Set of absorbers
- Collimator

This experimental set will enable students to investigate the following:

1. To classify radioactive and non-radioactive solids.
2. To investigate the randomness of the radiation emitted by a Radium 226 source.
3. To compare the activity of emitters.
4. To reduce the intensity of radiation emitted by a source.
5. To separate the radiation emitted by a Radium 226 source.
6. To investigate the rate of decay of a radioactive source and to determine the half-life of that decay process.
7. To determine the range of alpha particles in the air.
8. To investigate the absorption of beta particles in a metal.
9. To investigate the attenuation of gamma rays in lead.
10. To investigate the relationship between the intensity of gamma rays at a point and the distance of that point from the source.
11. To monitor the distribution in space of the emission from a radiation source.
12. To investigate the deflection of a stream of beta particles in a magnetic field.
13. To investigate the back scattering of beta radiation by solids.
14. To gauge the thickness of aluminium foil by the transmission of beta particles.
15. To gauge the level of a liquid or powder by the transmission of beta particles.

F4H27143	set **£179.99**

B Collimator, Simple Pattern

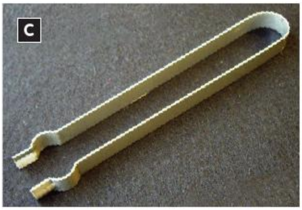
For use with a standard strontium source to produce a narrow fan-beam of beta particles in order to show deflection of beta particles in a magnetic field.

The collimator has a cylindrical aluminium body 32 x 25mm diameter with a 10mm deep recess in one end to accommodate the head of the source. A nylon screw is provided to lock the source into place. The other end of the body has a 1.5mm slot extending the full width of the body and as far as the source recess.

F4H27129	each **£9.99**

Radioactive Sources:

The active material is enclosed in metal foil fixed in a cylindrical mount provided with a stem of 4mm diameter. The foil is further protected from accidental damage by a wire gauze cap over the open 'window' of the mount. The nature and strength of each source is clearly engraved on its mount and it is also colour coded for identification. Each is supplied in a small lead 'castle' in a suitably labelled MDF storage box 100 x 75 x 65mm high. A data sheet is enclosed with each.



A Radioactive Sources

Direct Delivery – up to 6 weeks

Americium-241 kBq

5μCi (185 kBq) of Americium-241 incorporated in a silver-palladium disc which transmits a substantial proportion of the alpha particles and a small amount of low energy gamma emission.

- Emissions: α and γ
- Half-life: 458 years
- Colour code: Brown

F4A49591 each **£619.99**

Cobalt-60

5μCi (185 kBq) of Cobalt-60 covered by an aluminium disc to shield beta particles so that only gamma radiation is emitted.

- Emission: γ
- Half-life: 5.26 years
- Colour code: Green

F4A49589 each **£619.99**

Strontium-90

5μCi (185 kBq) of Strontium-90 in equilibrium with its daughter nuclide Yttrium-90, incorporated in a silver disc allowing the major proportion of the Beta radiation to escape.

- Emissions: β
- Half-life:28 years (strontium), 64 hours (yttrium)
- Colour code: Yellow

F4A49578 each **£619.99**

B Radioactive Mineral Specimens

Natural rocks of varied mineral content and radioactivity. Collected from areas as widely separated as Australia, North America and Cornwall. Because of this, the availability of specific rocks varies but the following list is typical of the rocks from which sets are selected: Pitchblende, Allanite, Torbenite, Monazite, Autunite, Davidite, Phosphuranylite. The set comprises four samples that are numbered for easy identification and are packed in a stout cardboard box. Special authorisation is not required by schools in England for this set.

F4A49619 set 4 **£20.99**

C Source Handling Tool

Simple forceps fabricated from a 9.5 x 1.5mm brass strip. The ends are shaped so that a source may be gripped firmly either by its peg or its main body. Overall length: 165mm.

F4A49608 each **£8.50**

Info

PURCHASING RADIOACTIVE SOURCES

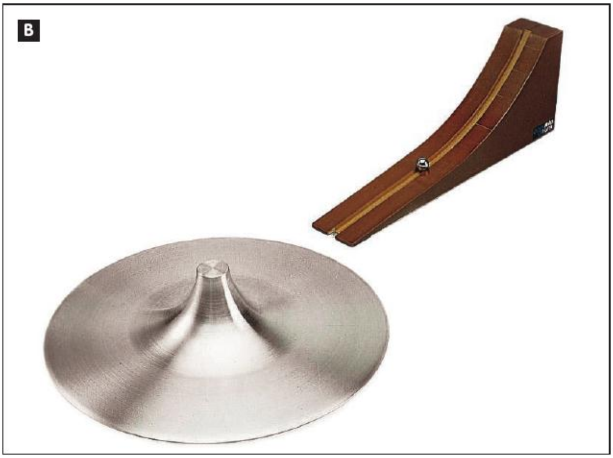
Letters of Authorisation are NOT required for:
- State schools in England
- Independent schools in England, Wales and Northern Ireland

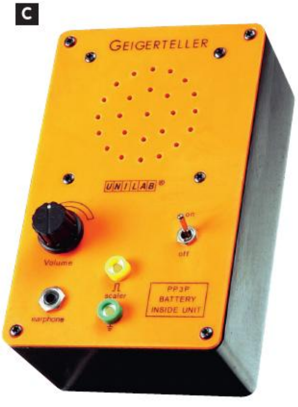
They ARE required for:
- State schools in Wales, from the Welsh Assembly Government.
- State schools in Northern Ireland from the Department of Education for Northern Ireland (DENI).
- State AND Independent schools in Scotland from the Scottish Government Education Directive.

The mineral specimens do not require any authorisation, but we recommend using the source handling tool. All schools are advised to adhere to the guidance contained in CLEAPSS document L93 "Ionising Radiations and Radioactive Substances", particularly the Standard School Holding in section 3.2

TRANSPORT OF RADIOACTIVE SOURCES

Radioactive sources require specific transport and therefore an additional delivery charge will be added to your order. Please call for details.





A Half Life Analogue

In the study of radioactivity, student practicals are difficult to organise because of the hazardous nature of the topic, but this apparatus offers students the opportunity to obtain realistic results in a perfectly safe way. The student set contains 10 trays and 500 small plastic cubes. The cubes have one face identified and represent radioactive nuclei which have "decayed" when this face is uppermost.

Ten groups shake their set of nuclei and roll them out onto the bench. For each throw the decayed nuclei are counted and removed from the set. Excellent results for an exponential decay curve are obtained with increased awareness of the link between activity and the number of nuclei present.

F4G85951 set **£62.99**

B Alpha Scattering Analogue Apparatus

For demonstrating Rutherford scattering by means of a gravitational analogue of inverse square law repulsion. The apparatus comprises a spun aluminium hill, 280mm diameter x 60mm high, a 12.5mm steel ball and a wooden launching ramp. The shape has been determined by varying its height above the base line by an amount based upon the reciprocal of the radius.

Launching ramp, 300 x 48 x 105mm high with a guide groove down its curved front face and index marks at 40, 60, 80 and 100mm above the base to give a variety of known launching heights.

F4H27179 each **£52.40**

C Geigerteller

A self-contained portable radioactivity detector. Each detected incidence produces an audible click, and a 9V pulse output via 4mm sockets.

Power: internal PP3 battery (not supplied)

Mass: 0.55kg Size: 170 x 95 x 75mm

F4H29371 each **£326.50**

A

B

A Planck's Constant Kit

- Direct method gives a reasonable order of magnitude value for Planck's constant, h
- Demonstration of photoelectric effect and the principle of applying a backing p.d. to reduce anode current to zero

The Planck's Constant Kit contains a photoelectronic unit, with six colour filters and a BNC to 4mm plug lead. The main unit contains a photoemissive Caesium Antimony cathode, with a spectral response of 185-650nm. When light of frequency, f, strikes the cathode, electrons of energy E=hf-W0 are released and would normally reach the anode, producing a current which can be registered on a very sensitive instrument such as a Picoammeter or an Electrometer.

The p.d. from an internal PP3 (6F22)-type cell can be adjusted to a value V where the anode current is just reduced to zero. V is proportional to the frequency of light used. This apparatus enables values of V to be found for various frequencies of light selected by placing each of the colour filters in turn over the cell. A plot of V vs. f gives a reasonable straight line where the gradient is h/e.

Items in the kit are available separately, and also a set of three narrow band filters for mercury violet, green and yellow lines from the spectrum of a mercury discharge lamp. These give a similar graph of the same gradient.

Contents include one of each of the following (which are available separately):

- Planck's Constant Unit with screened lead
- Colour filters
- Narrow band filter

Plus the following metering:

- Easy-Read Meter
- 20V d.c. attachment
- SpaceSaver Picoammeter

F4H76701 kit **£599.99**

B Planck's Constant Experiment

An interesting way to establish Planck's Constant, the experiment is complete and self-contained, presented in a battery-powered instrument case. A rotary switch selects one of the LEDs, viewable through holes in the sloping front panel. There are five LEDs of wavelengths 430mm, 565mm, 595mm, 620mm and 660mm. By adjusting the potentiometer, the voltage across the selected LED is raised until photon threshold is reached, shown by the LED just beginning to glow. At the threshold it is assumed that all electron energy released in re-combination is converted entirely to photon energy (any higher and phonon energy is is involved). The voltage across the LED is displayed on the built-in digital voltmeter, from which electron energy (and hence photon energy) can be calculated. Knowing the energy and the characteristic wavelength of the LED (indicated on the case), Planck's Constant can be determined. Please note this requires a PP3 battery.

F4H29024 each **£113.99**

Spares and Accessories

Planck's Constant Apparatus

Planck's Constant Unit

F4H28615 each **£399.99**

Narrow Band Filters

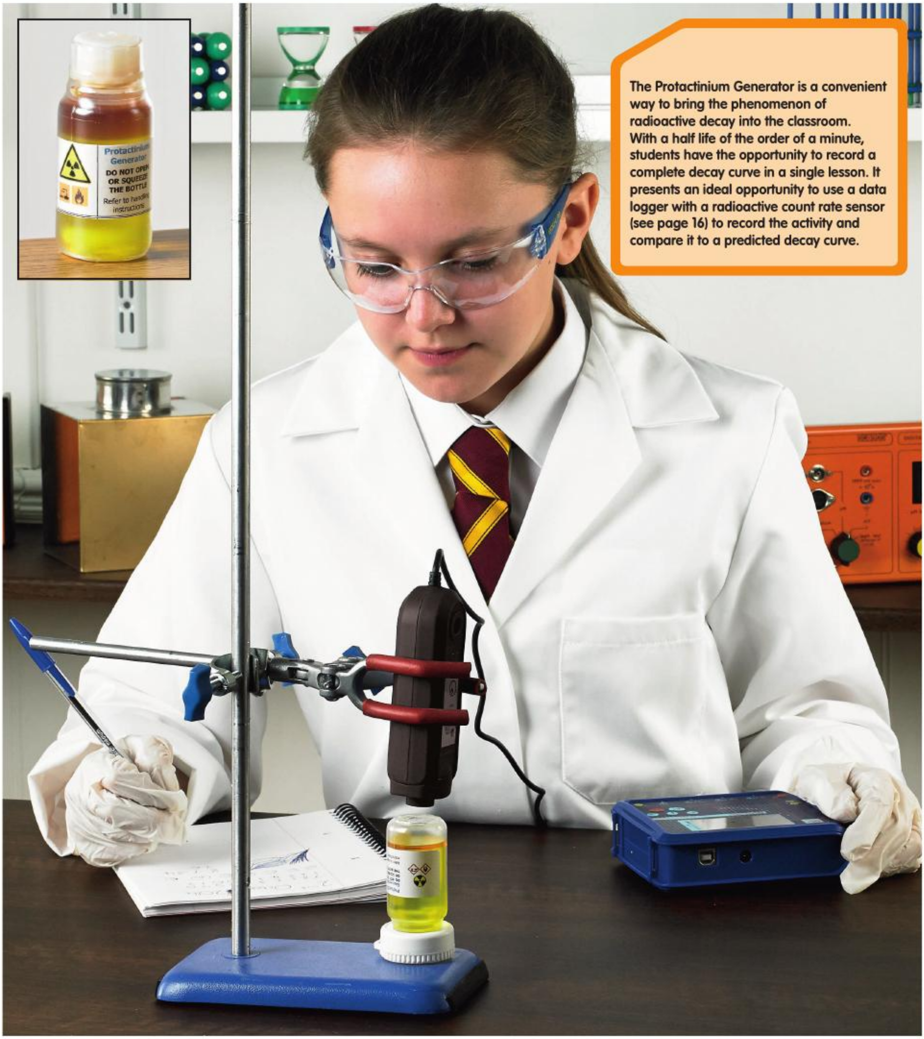
Recommended for A-level experiments.

F4R05397 pack 3 **£39.99**

Colour Filters

Standard colour filters.

F4R05396 pack 6 **£83.99**



The Protactinium Generator is a convenient way to bring the phenomenon of radioactive decay into the classroom. With a half life of the order of a minute, students have the opportunity to record a complete decay curve in a single lesson. It presents an ideal opportunity to use a data logger with a radioactive count rate sensor (see page 16) to record the activity and compare it to a predicted decay curve.

Protactinium Generator

Protactinium-234 has a half-life of about 70 seconds, and is ideal for the observation of radioactive decay. The isotope is a product of the Uranium-238 decay series.

The generator contains a uranium salt in acidic solution, plus a water-immiscible organic liquid. Pa-234 is soluble in this organic liquid. When the liquids are shaken together, the organic solvent selectively extracts the Pa-234. When allowed to resettle, a physical separation into two layers occurs, any Pa-234 is in the upper organic layer. The Pa-234 decay is monitored by a Geiger tube placed close to the top of the container, supported by a stand and clamp. Over a period of 5 to 10 minutes a clear half-life curve can be captured, manually or using a datalogger. Several factors combine to ensure that Pa-234 clearly exhibits its own half-life:

- Other decay products remain in the lower aqueous layer; alpha and beta radiation from these cannot penetrate the container.
- Pa-234 is a beta emitter with an energy spectrum going up to 2.3 MeV, sufficient to penetrate both the walls of the flask and some of the liquid in which the source is contained.

The generator is supplied in a sealed translucent container, which is virtually chemically inert with a leak-proof closure. This is packed in an outer container which is suitable for long term storage. The generator can be stored for a period of eight years, after which time disposal should be made through a commercial disposal agency or via the local authority.

Please note this is a non-returnable item. Only available for delivery to UK mainland addresses.

Data logger and sensor not included.

F4R01192 each **£237.95**

A Geiger-Muller Tube Holder

A cylindrical metal body 63 x 35mm diameter x depth which houses the tube socket and is mounted on a sheet metal stand with resilient rubber-strip feet. A captive co-axial connecting lead 1m long is provided, terminating in a standard BNC connector. A 2.2 MΩ protective stabilising resistor is internally wired in series with the anode connection.

F4H27155 each **£94.99**

B Geiger-Muller Tube Mullard ZP1481

This sensitive GM tube is ideal for detecting α, β and γ radiation and is recommended as a general purpose tube. The GM tube must be used with the GM Tube Holder (see below).

A removable protective mesh cap of plastic is fitted over the window and the body has a thin plastic coating.

- Sensitive to α, β and γ radiation.
- Threshold voltage (max.) 370V
- Plateau length (min.) 100V
- Operating temperature -55 to +75°C
- Dead time 100µs
- Anode/Cathode capacity 3.5pF
- Sensitivity for 1mR/L radium 1650 counts min-1
- Window thickness 2.5 mg cm-2
- Halogen quenched metal tube with thin end window
- Dimensions overall 76 x 26mm diameter

F4A49724 each **£344.99**

Geiger-Muller Tube (Tel-X-Ometer)

Comprising of a sensitive thin end window G.M. tube with mounting hardware to fit the radial arm of the Tel-X-Ometer. The tube is sensitive to α, β and γ radiation and X-rays. G.M tube type LND712.

To be used with Tel-X-Ometer.

- Dose rate range 10-3 to 10-2 mGy/h
- Window thickness 2.0 to 3.0 mg cm-2
- Bias voltage 500V
- Output connector BNC

Direct Delivery – up to 12 weeks

F4F64886 each **£239.99**

C Basic Accessory Set

20 components including collimators, luminescent screen, film cassettes and all the items necessary to perform more than twenty experiments. Thin foils of nickel, copper, cobalt and zinc are used to evaluate the mass absorption coefficient. They are also used in conjunction with a Rotary Radiator which presents the above four elements, plus with iron, vanadium, manganese, and chromium, to the primary X-ray beam to verify Moseleys Law. A single crystal of sodium chloride is used to establish the Bragg Relationships and finely divided sodium chloride powder can be mounted in the Powder Camera to study the Debye-Scherrer Pattern. Strands of wire covered with pure copper to provide the pattern for copper and finely drawn glass fibres are included so that Powder Camera experiments can be performed with materials of the users choice. The Powder Camera and film cassettes have been designed for use with the X-ray film kit described above.

Direct Delivery – up to 12 weeks

F4A46826 pack **£1124.99**

D S-Range Scaler-Timer

A general purpose scaler-timer suitable for radioactivity counting utilising Geiger-Muller tubes or solid state alpha particle detectors; and as a general purpose millisecond digital timing device with manual or electronic triggering. The bright L.E.D. has six digits, 14mm high, making it suitable for individual use or class demonstration. In the radioactivity mode an integral pre-amplifier is provided for solid state detectors and an adjustable 300 to 500V E.H.T. supply for G.M. tubes. Loudspeaker sockets are also provided for use when an audible indication of count rate is required. In the radioactivity mode, the display features 'most significant figure' blanking. In the timing mode, the display reads in seconds, i.e. from 0 up to 999.999s, and increments in ms. This provides a clean unambiguous display. Timing can be actuated manually or by light operated or mechanical switches and also incorporates triggered timing. Supplies of 2V and 6V a.c. at 0.5A are provided via front panel sockets for optical switch light sources, etc.

- Display: six-digit 14mm bright L.E.D.
- Timing oscillator: 1000Hz (1ms period) ±0.5%, typically ±0.2%
- Reset: push button
- Radio activity inputs: GM tube via BNC socket with integral 300-500V. supply via directly calibrated rotary control
- Timing inputs: (1) Manually switched start/stop; (2) Light gate operated start/stop; (3) Mechanical switch closure start/stop; (4) Triggered timing start/stop (i.e. momentary interruption of light beam)
- Outputs: 2V and 6V, 0.5A a.c.; Loudspeaker output via 4mm sockets
- Mains supply: 100-120V or 220-240V, 50-60Hz via detachable three-core mains lead with I.E.C. connector and moulded on mains plug (240V version)
- Power consumption: 8W
- Dimensions: W380 x D140 x H165mm

F4H28925 each **£431.99**

E S-Range Digicounter

A versatile counter suitable for timing, frequency, period and radioactivity measurement. A built-in high stability crystal controlled oscillator ensures a typical accuracy of 0.005% on all measuring ranges. The period measurement and display function enables very low frequencies to be measured rapidly with a high degree of accuracy. It also allows triggered timing of trolley speeds, etc., to be performed using a single light gate; and by shorting the period input, infinite radioactivity or frequency counts may be obtained.

Radioactivity

- Inputs: E.H.T BNC connector for a G.M. tube. Supply voltage adjustable from 300 to 500V
- Counting time: 1, 10, 100 or 1000 seconds and infinity. Can be set to take a single or a continuous series of readings, each being displayed for 3 seconds before the next is taken
- Rate: Obtained by dividing the count reading by the counting time
- Speaker: output will feed into a speaker of any impedance
- Timing Ranges: 0 to 99.9999 x 0.1ms; 0 to 999.999 x 1ms; 0 to 9999.99 x 0.01s (10ms); 0 to 99999.9 x 0.1s (100ms)
- Accuracy: better than 0.005% ±1 count
- Gating: (1) By manual front panel stop/start switch;(2) By make or break input sockets; (3) By triggering timing stop/start inputs. Output 2V and 6V a.c. at 0.5A for light gate or similar amps

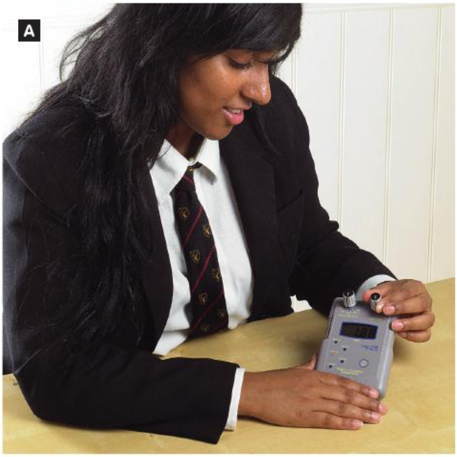
Frequency

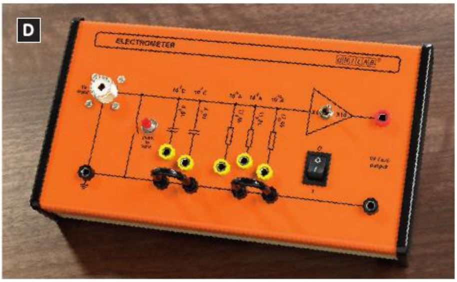
- Inputs: (1) Low frequency, d.c. to 3MHz minimum (5MHz typical). Will operate with T.T.L inputs, light gates etc.; (2) high frequency, capacitively coupled 30Hz to 3MHz minimum (5MHz typical); (3) High gain, input voltage required 0.8mV r.m.s. from 30Hz to 20kHz; recommended microphone - high impedance dynamic type
- Input impedance: 20Ω, inputs 1 and 2;100kΩ input 3
- Accuracy: Better than 0.005% -+ 1 count

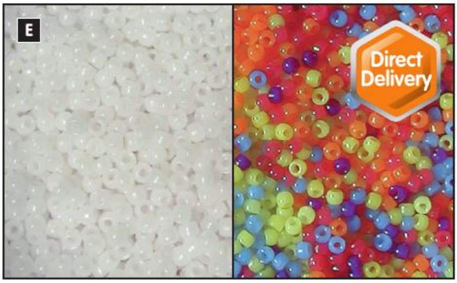
Period

- Timing intervals: 0.1, 1, 10 and 100ms

F4H29280 each **£619.99**







A Planck's Constant Experiment

An interesting way to establish Planck's Constant, the experiment is complete and self-contained, presented in a battery-powered instrument case. A rotary switch selects one of the LEDs, viewable through holes in the sloping front panel. There are five LEDs of wavelengths 430mm, 565mm, 595mm, 620mm and 660mm. By adjusting the potentiometer, the voltage across the selected LED is raised until photon threshold is reached, shown by the LED just beginning to glow. At the threshold it is assumed that all electron energy released in re-combination is converted entirely to photon energy (any higher and phonon energy is is involved). The voltage across the LED is displayed on the built-in digital voltmeter, from which electron energy (and hence photon energy) can be calculated. Knowing the energy and the characteristic wavelength of the LED (indicated on the case), Planck's Constant can be determined. Please note this requires a PP3 battery.

F4H29024 each **£113.99**

B Ultraviolet Lamp TUV6

A tubular bulb with an E.S. cap. For use on 200-260V a.c. mains supply, no control switch gear required. The principal emission of the bulb is at 253.7nm, giving an energy output of 85mW at this wavelength.

- Nominal mains voltage: 220 V a.c
- Lowest starting voltage: 170V
- Tube current: 0.027A
- Tube consumption: 6W
- Burning position: All positions
- Dimensions: 150 x 26mm diameter
- Light centre: 92mm from tip of cap

F4A56935 each **£114.99**

C UV Lamp

Portable, ultra violet, black light lamp.

F4R05625 each **£10.45**

D Electrometer

Modern components and construction ensure much improved performance, reliability and robustness. For example, captive J-links are used to select the capacitance or current range required, while no zero control is required.

The internal 9V PP3 battery should give at least 6 months continuous use.

This instrument gives outputs in the range 0-1V in response to extremely small currents or charges. An external 1V voltmeter is used to show the reading. Selecting one of the 1nF or 100nF capacitors or 10MΩ, 1000MΩ (1GΩ) or 100GΩ resistors, (the x1 and x10 gain switch on the amplifier provides the decades between these values) means that current ranges from 100nA to 1pA or charge ranges from 107 to 109 Coulomb can be measured.

All 4mm sockets are PTFE insulated to minimise leakage currents.

The input socket is a UHF socket with 4mm central socket.

F4H28792 each **£129.99**

E Ultraviolet Detecting Beads

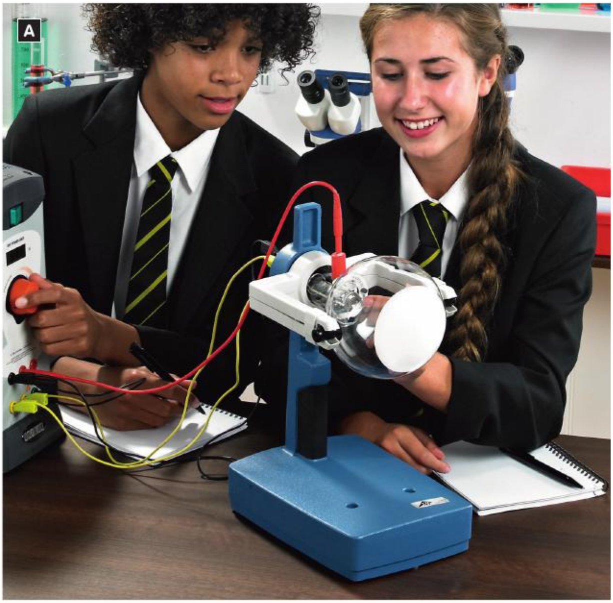
A fun way to learn about the power of sunlight. As well as making bracelets, pupils are able to carry out fun experiments investigating solar radiation, effectiveness of suncream and sunlight. A science activity guide is included and allows children to carry out scientific investigations and learn about the effects of the sun on their health.

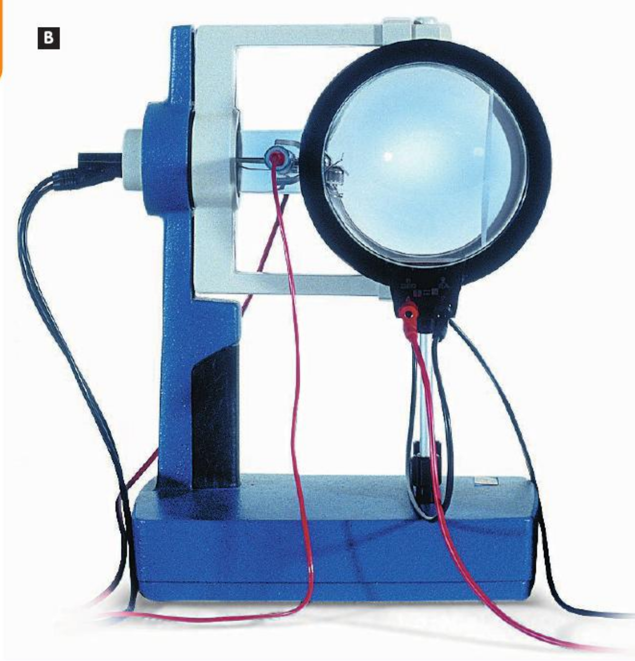
- Observe radiation from the Sun at different times of the day
- Test the effectiveness of glass in blocking the Sun's rays
- Test the effectiveness of different SPF sunscreen

A bag of white beads which turn into many different colours when exposed to an ultraviolet light source. Ideal for observing UV radiation from the Sun. Beads are drilled so that they can be threaded onto pipe-cleaners or string. A great way to raise awareness of the health issues associated with exposure to the sun.

Direct Delivery – up to 10 days

F4L87567 pack **£12.99**





Teltron range

The Teltron range of discharge tubes has been designed to show the properties of the free electron and is suitable for demonstration or individual student use.

A Universal Stand (see left) is available enabling the tubes to be securely mounted and displayed in the appropriate position. A pair of Helmholtz coils is also available which plug into sockets in the base of the Universal Stand on either side of the tube. Each tube has a hot cathode and works at or below 5kV, thus obviating any harmful radiation.

All of the tubes except the Demountable Discharge Tube have a spherical glass envelope 135mm diameter, with a cylindrical neck housing the filament or electron gun, the connections for which are made through 4mm sockets in the plastic cap. Other connections are made via 4mm plugs or sockets on caps on the glass body.

A range of meters, digital or analogue, suitable for monitoring voltages and currents in Teltron tube set ups may be used.

A Electron Diffraction Tube

The tube uses an electron gun with an indirectly heated cathode to project a narrow converging beam of electrons through a thin layer of graphiticised carbon supported on a fine mesh grid over the exit aperture of the gun. The cathode rays are diffracted in passing through the carbon layer and produce a ring pattern on the phosphor coated end of the tube. Study of the ring pattern and its variation with different anode voltages permits the study and verification of the de Broglie hypothesis, shows the dual nature of the electron, permits the calculation of the spacing of diffracting planes and suggests the probable arrangement of carbon atoms. Use with the Universal Stand.

- Filament voltage: ≤7.5Va.c./d.c.
- Anode voltage: 2000 to 5000Vd.c.
- Anode current: typical 0.15mA at 4000Vd.c.

Supplied complete with instructions.

F4A49566 each **£604.99**

B Double Fine Beam Tube, Gas Filled

Helium filled, electron beams may be observed throughout the full length of their travel within the tube, a green glow being emitted during the gas/electron collisions. The tangential beam can be deflected by use of Helmholtz coils to produce a completely circular path permitting e/m measurements to be made. Clear free path studies may be made and phenomena such as screen blanking due to charge build up on the screen may be observed. Within the tube are mounted two electron guns with indirectly heated cathodes, the one gun pointing along the axis of the tube, while the other is tangential to the axis, either gun being selected by a switch on the cylinder cap. The angle of projection from the guns is adjustable by means of miniature deflection plates near the gun outlets, a small potential being applied via 4mm connections at the side of the cylindrical neck. The end of the body has a phosphor coated screen for use with the axial gun. Use with the Universal Stand.

- Anode voltage: max 100Vd.c.
- Anode current:max 30mA
- Filament voltage: max 7.5Va.c./d.c.
- Deflector voltage: max 50Vd.c.

Supplied complete with instructions.

F4A49554 each **£603.50**

A 20mA d.c. Easy-Read Attachment

At least one attachment should be purchased for each Easy-Read Meter. Use the d.c.10A attachment for the current in the Helmholtz Coils and the 20mA d.c. attachment for the anode currents in the Teltron tubes.

F4H31158 20mA d.c. Attachment each **£19.99**

B Planar Diode

The diode is used to show the basic thermionic effects in vacuum tubes, including:

Current flow between an incandescent filament and a cold electrode (the Edison effect). Determination of e/m by the displacement method using Helmholtz coils.

Characteristic anode current/anode voltage curves for different filament temperatures.

Application of a diode as a rectifier.

The diode consists of a basic glass spherical body with a cylindrical neck, containing a tungsten filament with 4mm connections sockets in the plastic cap on the neck and a circular anode plate connected to a 4mm plug connection on the sphere. Use with the Universal Stand.

- Optimum anode voltage: max 500V
- Maximum anode current: 2.5mA at 300V
- Maximum filament voltage: 7.5V

Supplied complete with instructions.

Direct Delivery – up to 12 weeks

F4A49505 each **£349.99**

C Perrin Tube

The Perrin tube may be used to show that charge can be accumulated in the Faraday pail incorporated, that the charge does not disappear when the filament is switched off and therefore that the cathode rays must consist of charged particles. Electron deflection sensitivity may be measured using Helmholtz coils to deflect the beam.

Cathode ray tube operation may also be demonstrated, using a 'secondary coil' for the transverse field. The tube comprises a standard spherical glass body with a cylindrical neck containing a diode electron gun with filament and cylindrical anode, and a Faraday's pail in the sphere, at 45° to the axis. Connections to the diode electron gun are via 4mm sockets in the moulded cap and the Faraday's pail connection is via a 4mm plug in one of the side caps. The end of the sphere has an internal phosphor coating providing a luminescent screen. Use with the Universal Stand.

- Maximum filament voltage: 7.5V.
- Anode voltage: 2000 to 5000V.
- Typical operation at 4000V: anode current 1.8mA beam current 4μA.

Supplied complete with instructions.

F4A49529 each **£434.40**

D Maltese Cross Tube

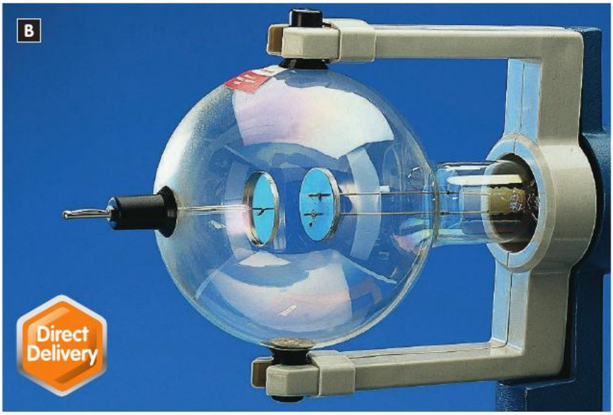
For showing the linear propagation of cathode rays, magnetic deflection of cathode rays, image distortion due to electrostatic charging, comparison of cathodic stream and electromagnetic radiation and an introduction to electron optics using a single Helmholtz coil.

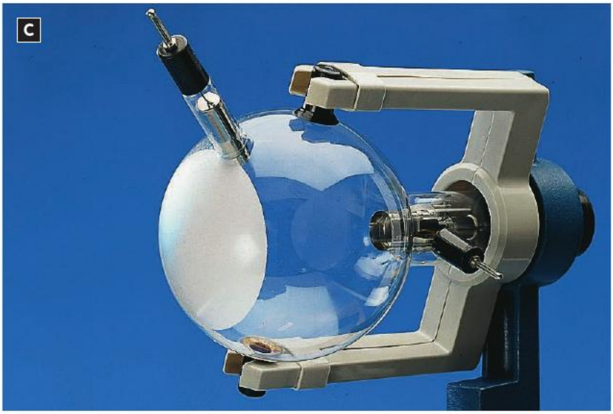
The tube comprises the standard spherical glass body with cylindrical neck, a diode electron gun with a filament and cylindrical anode connected to 4mm sockets in the plastic cap, a metal Maltese cross mounted in the centre of the sphere, (connected via a 4mm plug in one of the side caps) and a phosphor coated screen. Use with the Universal Stand.

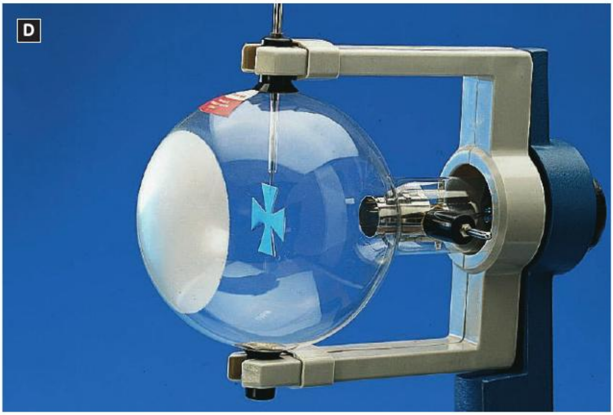
- Maximum filament voltage: 7.5V
- Anode voltage: 2000 to 5000V
- Anode current: 4000V 1.8mA

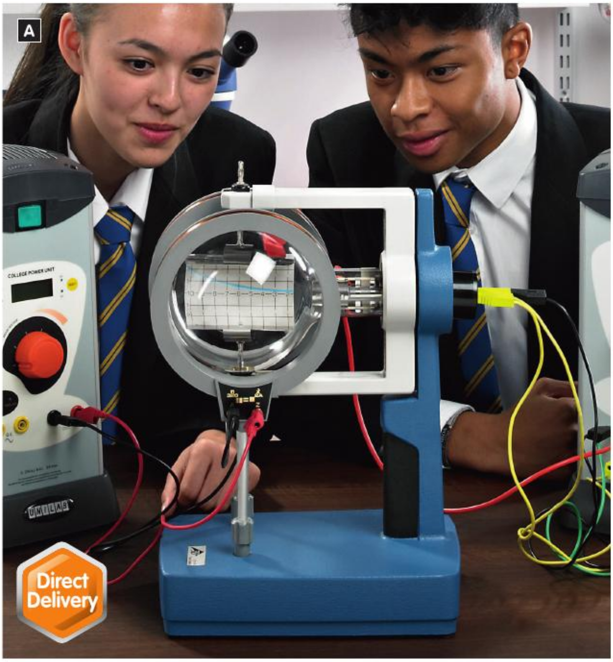
Supplied complete with instructions.

F4A49517 each **£385.90**









A Deflection e/m Tube

For determining e/m by balanced electrostatic deflections or by magnetic deflection using the Helmholtz coils.

Simple electrostatic and magnetic deflection may be demonstrated and the relationships shown between the plate potentials or coil currents and the degree of deflection. The 'electron mirror' effect producing trochodial spirals is easily shown and also the magnetic focusing at points along the trochoid.

The tube is the standard glass sphere with cylindrical neck and has a diode electron gun with filament and cylindrical anode. In the centre of the sphere and angled at 15° across the axis is a mica screen 90mm long x 60mm high approximately, divided 2 to 10cm along its horizontal axis and 2-0-2cm vertically. The undivided side is coated with phosphor and produces a clear fluorescent trace when irradiated by the electron beam. The top and bottom edges of the mica plate are supported by horizontal metal plates which are connected to 4mm plugs in the side caps and provide the electrostatic deflection field when connected to an E.H.T. supply. Use with the Universal Stand.

- Maximum filament voltage: 7.5V
- Anode voltage: 1000 to 5000Vdc
- Typical operation: 2000 to 4500V
- Anode current: 0.1mA approx. at 4000V

Supplied complete with instructions.

Direct Delivery – up to 2 weeks

F4A49530	each **£546.99**

B Helmholtz Coils

Connected to a suitable d.c. supply, the coils provide a substantially uniform field in the central space. Each coil has a moulded plastic former 152mm diameter with 320 turns of 22 s.w.g. enamelled wire giving a mean diameter of 136mm. The former is mounted on a boss provided with two 4mm sockets and is fitted with a support rod. The rod has a sliding boss which locks into the tapered hole in the base of the Universal Stand.

Dimensions of coil and support rod 305 x 152 x 25mm. Use with the Universal Stand.

Supplied complete with instructions.

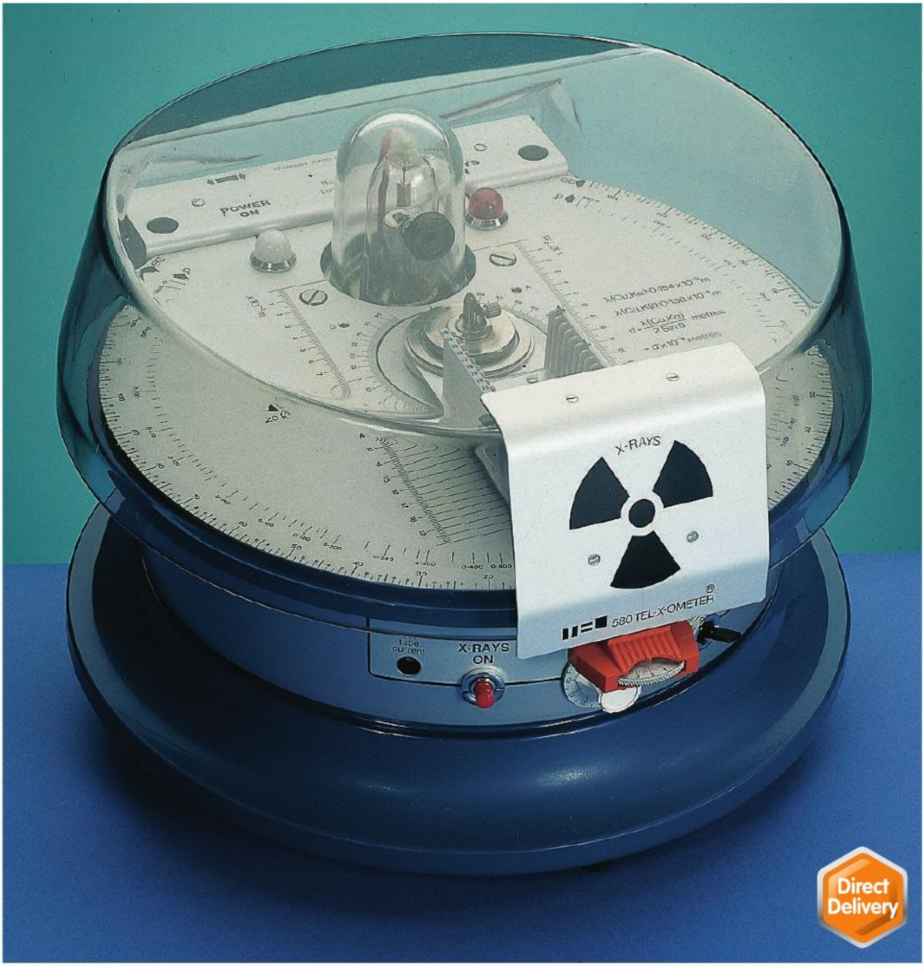
F4A49475	each **£252.50**

C Universal Stand

Designed to accommodate the whole range of Teltron tubes and accessories. The base, 240 x 180 x 50mm, and a vertical arm of the stand, 280mm high, are cast in light alloy and stove enamelled.

Three rubber feet ensure maximum stability. Tube mounting jaws are provided, moulded in a material with very high electrical insulation properties. The jaws are split lengthways to admit the side caps of the tubes, and clamps sliding on the jaws lock them securely in position. The jaws, 160mm long x 140mm separation, have an integral hollow boss which is secured in the stand by a rubber 'O' ring at a centre height of 263mm, permitting a full 360° rotation so that the tube may be displayed to the best advantage. Sockets in the base accommodate the Helmholtz coil supports and locate the coils accurately either side of the tubes. A 4mm earthing socket is drilled into the pillar base. Supplied complete with instructions.

F4A49463	each **£229.99**



Tel-X-Ometer

The Tel-X-Ometer enables investigations to be carried out in the normal school laboratory. Extensive safety precautions are built into the apparatus, which conforms completely to the recommendations of the International Commission on Radiological Protection, 1968.

Schools should check CLEAPSS guide L93 Ionising Radiations and Radioactive Substances before purchase.

The radiation level at 50mm from any part of the surface of the instrument does not exceed 0.5mR per hour. Also, in accordance with the recommendations laid down, a warning card is supplied with each instrument for affixing to the door of the room where the experiments are to be conducted.

The apparatus is in effect an X-ray spectrometer which, by means of simple adaptations, will fulfil a range of requirements as follows:

- A broad beam of X-rays for analysis of their general properties
- Single crystal Bragg Diffractometer having a scale accuracy of 5 minutes of arc
- Powder Camera for Debye/Scherrer experiments to an accuracy of 30 minutes of arc
- Fluorescent radiation emitter for a study of the Moseley Theory
- An experimental region for the mounting of innovative studies of the teachers choice.

Specification:

A specially designed miniature X-ray tube is used which protrudes through the cast aluminium base of the spectrometer table and is enclosed within a thick walled lead glass dome.

The apparatus is supplied with the X-ray tube installed and aligned for immediate use. Every instrument is carefully checked under working conditions before dispatch, in addition to thorough testing of the X-ray tube itself.

Mains power is supplied via 2m of 3-core cable and a sector enables the instrument to operate on voltages between 110 and 240, at 50 to 60Hz.

A detailed instruction book is provided giving set-up details, notes for 25 experiments (using the accessory set) and teacher's notes. Height 250mm, diameter 370mm. Mass 9kg. Supplied complete with X-ray tube.

Direct Delivery – up to 12 weeks

F4A46784 each **£5499.99**

Laika: Raspberry Pi Robotics Interface

Laika takes Raspberry Pi to the next level. Together, Raspberry Pi and the Explorer^2 enable you to quickly and easily create amazing projects without feeling overcome with circuit diagrams and tricky electronics. All Laika products are robust and are designed to industrial standards giving you the freedom to experiment and gain the confidence you need to make teaching or learning computing and robotics easy.

You can begin with the Laika Explorer^2 which comes with everything you need to start. It plugs into your Raspberry Pi and allows you to control motors, switches, lamps, relays, solenoids and much more, all through programming in Scratch or Python.

All Laika projects come with comprehensive teaching materials guiding you through each step from switching on for the first time through to having a complete system running, reading inputs and controlling outputs.

Laika is the easiest way to teach the principles of robotics and hardware control through software programming. Students can control motors through scratch or python with simple coding, but allows more complex problem solving as their knowledge grows.

A Laika Explorer^2

Laika is a sensational system merging the worlds of computing and science. Take an Explorer^2 and a Raspberry Pi or a Windows PC, and together you can automate and control your science experiments live in the classroom. Supplied with an SD card for the Raspberry Pi with all software installed and ready to go, with easy to follow, lesson based examples and tutorials you will be amazed at what you can achieve with Laika. Once set up by plugging the Explorer^2 directly into a Raspberry Pi or PC via USB, you can write refreshingly simple code to control all the features Laika has to offer.

Students are able to control and interface to motors, thermistors, potentiometers, lamps, breakout boards and more: it is a great way to learn about how electronics can be controlled by software. You can start with a simple temperature data logger and view the results live over your network or even on the web!

Kit contains 1 x Laika Explorer^2, 1 x 9v dc power adapter, 1 x USB lead, 1 x SD card installed with all software for Raspberry Pi and 8 x 4mm banana leads.

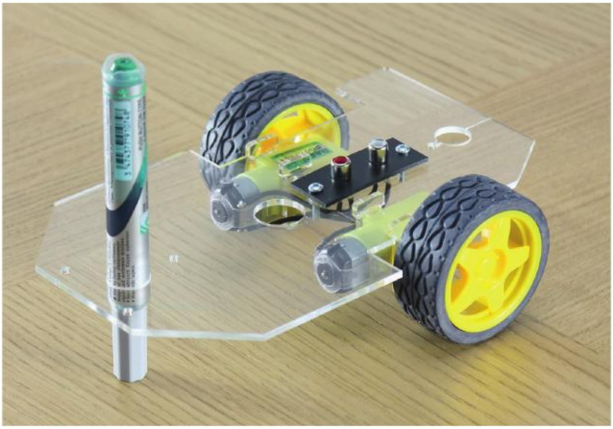
F4R05638	kit **£199.99**

B Laika Buggy

The Laika Buggy is a classroom essential and a quick and simple way to teach introductory robotics. You're really just controlling two motors but this little platform brings it all to life with a drawing buggy robot. Simply push a whiteboard marker through the mounting hole and write code to draw shapes. Suitable for use in Primary and Secondary classrooms, this easy to use platform is an excellent starting point, making programming fun at all levels.

Kit contains 1 x Laika Buggy, 2 x phono to 4mm banana leads and 1 x whiteboard marker.

F4R05640	each **£49.99**



A Raspberry Pi™ 2 Model B Plug 'N' Play Kit

As the Raspberry Pi™ Model B Starter Kit, but with the addition of a USB Mouse and Keyboard, USB WiFi dongle, HDMI and Ethernet cables.

Direct Delivery – up to 7 days

F4R05765 kit **£69.99**

C Raspberry Pi™ 2 Model B Media Centre

Designed to provide a value for money media centre solution. Stream audio, video and other digital content once kit is built. Kit contains Raspberry Pi™ Model B, 8GB micro SD card with adaptor and OS, micro USB, Black Multicomp™ case, HDMI cables, remote control, wireless receiver and full user guide.

Direct Delivery – up to 7 days

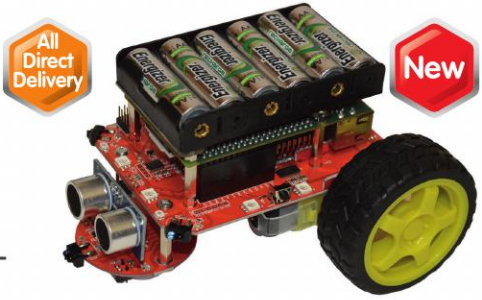
F4R05768 kit **£79.99**

E Raspberry Pi™ 2 Model B Camera Kit

Get started capturing standard and high definition photos and videos with this easy to use camera kit. Ideal for time lapse and slow motion photography, making it suitable for wildlife projects. Infra Red feature. Case allows camera board to be mounted in a number of ways. Kit contains Raspberry Pi™ Model B, 8GB micro SD card with adaptor and OS, micro USB, clear Multicomp™ case, USB WiFi wireless dongle, NoIR camera board and full user guide.

Direct Delivery – up to 7 days

F4R05766 kit **£59.99**

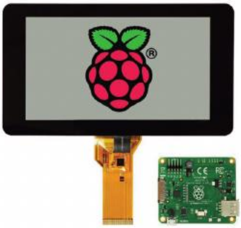


B Raspberry Pi™ Pi2 Go Robot

Supports all models of Raspberry Pi™, no separate chassis as all connections on main board. 5V switching regulator supplies the Pi and Pi2Go, 2 DC motors, 3x IR obstacle sensors detects objects within 10cm, 2x IR line sensors to program the Pi2Go to follow lines. Ultrasonic distance sensor for distance to objects. Non-dedicated switch to change mode, switch off, etc. 4 Pairs of controllable RGB LEDs, 4 Light sensors with analogue to digital converter built in, 4 Servo outputs controlled by onboard hardware. Active power supply monitor. No soldering required. Requires 6 x AA batteries (not included).

Direct Delivery – up to 7 days

F4R06340 each **£59.99**



D Raspberry Pi™ Touchscreen Display

Turn your Raspberry Pi™ into a touchscreen tablet, infotainment system or stand alone device. 10 Finger capacitive touch. Screen dimensions: 194 x 110 x 20mm, viewable screen size: 155 x 86mm. Screen resolution 800 x 480 pixels. Includes: Adaptor board, DSI ribbon cable, 4 x Stand-offs and screws and 4 x Jumper wires.

Direct Delivery – up to 7 days

F4R06325 each **£49.99**

F Raspberry Pi™ Sense HAT

The Raspberry Pi™ Sense HAT is attached on top of the Raspberry Pi™ via the 40 GPIO pins. The Sense HAT has several integrated circuit based sensors that can be used for many different types of experiments, applications, and even games. Includes: Gyroscope, Accelerometer - Linear acceleration sensor, Magnetometer - Magnetic Sensor, Barometer, Temperature sensor, Relative humidity sensor, 8x8 LED Matrix display and a Small 5 button joystick.

Direct Delivery – up to 7 days

F4R06324 each **£29.99**

A

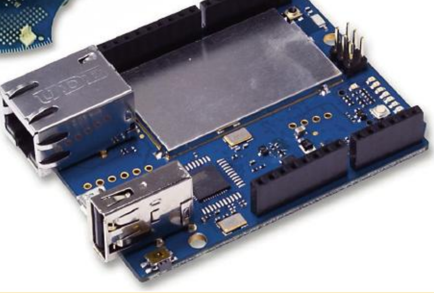
Arduino is an open-source electronics platform based on hardware and software that is easy-to-use for beginners, yet flexible enough for advanced users. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, or publishing something online. You can tell your board what to do by sending instructions to the microcontroller using the Arduino programming language and Arduino Software (IDE). Using these tools, your Arduino can be used in a whole range of science and engineering projects – from exploring the principles of chemistry or physics, to getting started with programming and robotics.

B

All New

All Direct Delivery

C



A Basic Level Workshop Kit

The basic level workshop kit contains an Arduino uno board and all necessary components to participate in an Arduino workshop.

Kit Includes: 1 x Arduino uno board, 1 x USB cable, 1 x straight single line pinhead connectors 2, 54 40 x 1, 1 x breadboard 840 tie points, 1 x set of 70 breadboard jumper wires, 5 x 10K Ohm resistors 1/4W, 5 x 2.2K Ohm resistor 1/4W, 10 x 220 Ohm resistors 1/4W, 5 x 330K Ohm resistors 1/4W, 5 x 100nF capacitor polyester, 5 x 10nF capacitor polyester, 3 x 100uF electrolytic capacitor 25Vdc, 1 x 4.7K Ohm thermistor, 1 x 70-100K Ohm LDR VT90N2, 3 x 5mm red LED, 1 x 5mm green LED, 1 x 5mm yellow LED, 1 x 10Kohm potentiometer pcb terminals, 2 x BC547 transistor in TO92 package, 1 x piezo buzzer, 5 x PCB pushbutton 12 x 12mm, 2 x 4N35 Optocoupler DIL-6, 2 x Tilt sensor, 1 x Diode 1N4007 and 1 x MOS IRF520.

Direct Delivery – up to 2 weeks

F4R06218	kit **£44.99**

B Arduino Robot

The Arduino robot is the first official Arduino on wheels. The robot has two processors, one on each of its two boards. The Motor Board controls the motors, and the Control Board reads sensors and decides how to operate. Each of the boards is a full Arduino board programmable using the Arduino IDE. Both Motor and Control boards are microcontroller boards based on the ATmega32u4. The Robot has many of its pins mapped to on-board sensors and actuators. Programming the robot is similar to the process with the Arduino Leonardo. Both processors have built-in USB communication, eliminating the need for a secondary processor. This allows the Robot to appear to a connected computer as a virtual (CDC) serial/COM port. As always with Arduino, every element of the platform - hardware, software and documentation - is freely available and open-source. This means you can learn exactly how it's made and use its design as the starting point for your own robots.

Control Board Summary: Microcontroller ATmega32u4, Operating Voltage 5V, Digital I/O Pins 5, PWM Channels 6, Analog Input Channels 4 (of the Digital I/O pins), Analog Input Channels (multiplexed): 8, DC Current per I/O Pin: 40 mA, Clock Speed: 16 MHz, Keypad: 5 keys, Full colour LCD, SD Card reader, Speaker 8 Ohm, I2C Soldering ports 3, Prototyping areas 4

Motor Board Summary: Microcontroller ATmega32u4, Operating Voltage 5V, Digital I/O Pins 4, PWM Channels 1, Analog Input Channels 4 (same as the Digital I/O pins), DC Current per I/O Pin 40 mA, IR line following sensors 5, I2C Soldering ports 1, Prototyping areas 2.

Direct Delivery – up to 2 weeks

F4R06219	each **£149.99**

C Arduino YUN Board

Arduino YUN is a member of a new line of wi-fi products combining the power Linux with ease of use of Arduino. The Arduino YÚN is the combination of a classic Arduino Leonardo (based on the Atmega32U4 processor) with a wi-fi system-on-chip running Linino (a MIPS GNU/Linux based on OpenWRT). The Linux machine is embedded directly on the PCB of the Arduino Leonardo and the two are connected so that from Arduino it's very easy to run commands on the Linux side and use it as an ethernet and wi-fi interface.

ATmega32u4 Arduino microcontroller: Operating Voltage 5V, Input Voltage 5V, Digital I/O Pins 20, PWM Channels 7, Analog Input Channels 12, DC Current per I/O Pin 40mA, DC Current for 3.3V Pin 50mA, Flash Memory 32 KB (of which 4 KB used by bootloader), SRAM 2.5 KB, EEPROM 1 KB, Clock Speed 16 MHz, Atheros AR9331 Linux microprocessor: Architecture MIPS @ 400MHz, Operating Voltage 3.3V, Ethernet IEEE 802.3 10/100Mbit/s, Wi-Fi IEEE 802.11b/g/n, USB Type-A 2.0 Host/Device, Card Reader Micro-SD only, RAM: 64MB DDR2, Flash Memory 32MB.

Direct Delivery – up to 2 weeks

F4R06220	each **£49.99**

A
New
15 PIECE INCH SIZE LONG ARM SERIES
15 PIECE METRIC SIZE SHORT ARM SERIES

A 30 Piece Hex Set

A comprehensive 30 piece hex key set covering both metric and imperial keys down to small micro sizes which are not normally included in sets. Clean finished ends. Robust folding case. Contains metric standard length keys, 0.7mm - 10mm. Contains imperial long series keys, 0028in - 3/8in.

F4R06100 set **£9.99**

B Precision Screwdriver Kit

6 piece set contains 1.4mm, 1.8mm 2.3mm and 3mm slot and no.0 and no.1 crosspoint tip screwdrivers. Hardened blades. Chrome plated polished handles with serrated grip. Hexagonal revolving heads.

F4R06099 kit **£3.50**

C Crocodile Clips

With strong spring and clamping screw for wire.

F4A58671 pack 10 **£1.33**

D Crocodile Clips - Plastic Sleeved

An essential resource for any student building circuits, these allow addition of materials for investigation of conductance. Thread wire through and screw clockwise, or push-fit onto the ends of standard plug leads. Applicable to Year 4 of Key Stage 2: Electricity. Colours may vary.

F4A58695 pack 10 **£2.70**

E BNC to 4mm Socket Adaptor

The BNC to 4mm adaptor connects two 4mm plugs to a BNC socket.

F4R05704 each **£7.99**

F Plug Leads, Safety Type with Rigid Sleeve

A heavy-duty 4mm lead providing maximum operator safety by the incorporation of a rigid, non retractable insulating sleeve which completely encloses the plug pin.

- Maximum current rating: 32A
- Maximum working voltage: 1000V ac (tested to 4000V ac)
- Operating temperature range of lead insulation: -10 to +70°C
- Insulation material: PVC
- Nominal length: 1m

F4R05926	Black	each **£6.99**
F4R05927	Red	each **£6.99**

G Stackable Plugs

The 4mm pin has a spring insert and the rear of the plug has a 4mm socket. The hexagonal bodies are of resilient moulded plastic and the wire is attached by means of a clamping screw in the bottom of the socket. Maximum current carrying capacity: 10A.

		each
F4A59432	Black	**£0.62**
F4A59444	Red	**£0.62**
F4A59456	Yellow	**£0.60**
		pack 10
F4R01998	Black	**£4.50**
F4R01999	Red	**£4.50**
F4R02068	Yellow	**£4.50**

H 2mm Stackable Plug Leads

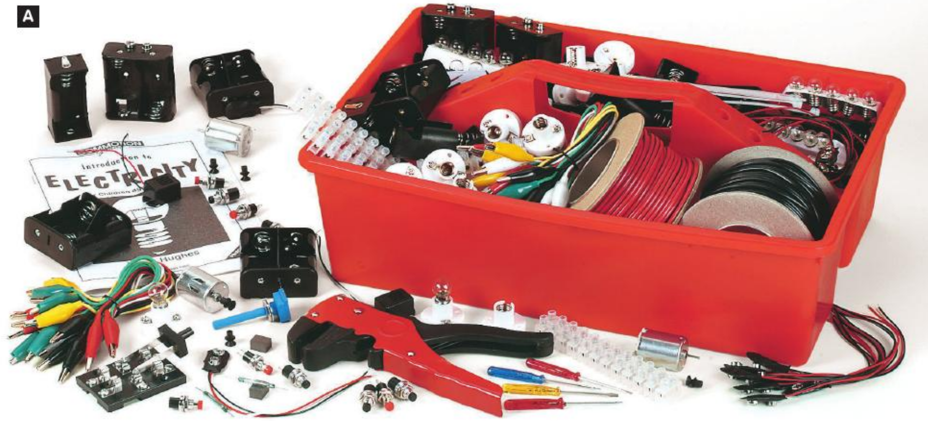
Ideal for use where 4mm plug leads would be too bulky. The plugs have nickel plated split hollow pins and are connected by high quality flexible wire. Maximum current: 12A.

	Colour	Length	each
F4R05922	Black	300mm	**£2.15**
F4R05923	Red	300mm	**£2.15**
F4R05924	Yellow	300mm	**£2.15**
F4R05928	Blue	300mm	**£2.15**

I 4mm Stackable Plug Leads

Current carrying capacity 19A maximum.

	Colour	Length	each
F4R05705	Black	100mm	**£2.55**
F4R05706	Red	100mm	**£2.55**
F4R05707	Yellow	100mm	**£2.50**
F4R05708	Black	250mm	**£2.75**
F4R05709	Red	250mm	**£2.75**
F4R05710	Yellow	250mm	**£2.75**
F4R05711	Black	500mm	**£2.99**
F4R05712	Red	500mm	**£2.99**
F4R05713	Yellow	500mm	**£2.99**
F4R05714	Black	750mm	**£3.50**
F4R05715	Red	750mm	**£3.50**



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A Primary Electrics Kit

Over 150 components in a storage box, allowing students to construct circuits, identify components and investigate different functions. Applicable to Year 4 and 6 of Key stage 2: Electricity. Pack includes 10 x MJR3L 3.5 6 volt motors, 20 x 6 volt MES screw bulbs, 20 x MES button holders, 2 x 6 volt buzzers, 10 x 7.9mm push fit pulleys, 10 x cable ties, 20 x PP3 battery snaps, 10 x (2 x HP11) battery holders, 10 x (4 HP11) battery holders, 1 x 100m red multicore wire, 1 x 100m black multicore wire, 20 x double-ended crocodile-clip leads, 5 x 5 amp connector strips, 1 x automatic wire stripper/cutter, 4 x 3mm electrician's screwdrivers, 5 x push-to-make red switches, 5 x push-to-break black switches.

F4R06042 kit **£127.99**

B Class Electricity Pack

Applicable to Year 4 of Key stage 2: Electricity. Includes: 10 x 2AA battery holders, 5 x MES bulb holders, 10 x 2.5V MES bulbs, 5 x red push switches, 3 x SPST toggle switches, 2 x DPDT toggle switches, 2 x reed switches, 2 x lever switches, 5 x electric motors, 1 x 3V buzzer, 5m of red connecting wire, 40 x mini croc clips and a photocopiable 18 page 'Introduction to Electricity' guide.

F4R06043 kit **£49.99**

C Plug-In Electricity Cost Monitor

Use the meter to monitor and measure the energy useage of any 13 amp rated electrical appliance. Plug the meter in to a powered mains socket and then plug the appliance you want to monitor into it. It also calculates the cost of electricty used and assesses the carbon footprint.

- Voltage Rating: 240V ac 50Hz
- Current rating: 13A
- Maximum load: 3120W
- Power Consumption: 0.5W
- Metering: Voltage 200 to 276V AC,. +/-1.5%
- Frequency range 45 to 65Hz
- Current range 0.005 to 13A, +/-2%
- Power range 0.1 to 3120W, +/-2%
- Power Factor: 0.00 to 1.00
- Overload power setting and alarm
- Accumulative electricity usage range

F4R05543 each **£14.99**

D Plug In PSU 5V 2A

This 5V 4A regulated plug-top power supply is suitable for the Unilab LED range, and data loggers.

F4R05925 each **£9.99**

A Antex Soldering Iron

Soldering iron utilising double shaft construction principle to give near perfect insulation. Supplied with 2.3mm bit. Operating tip temp 390°c.

F4R05681	each **£21.99**

Soldering Iron Bit

F4R05684	0.5mm	each **£4.99**
F4R05682	2.3mm	each **£4.99**
F4R06356	3mm	each **£4.99**

B Desoldering Pump

A high quality desoldering pump with double O ring washers for increased suction. The Teflon nozzle is removable so easy to clean or replace. Lightweight and easy to use. 200mm long and 20mm diameter.

F4R05687	each **£3.99**

C Omega Lead Free Solder

Omega lead-free solder is manufactured in the U.K. from 96% tin, 3.5% silver and 0.5% copper. It is rosin-free, halide-free and has a flux content of 3%. A fast flow solder, with good solderability, minimal clear residue and a melting point of 217°C.

F4R05689	18 SWG	250g reel **£32.99**
F4R05690	22 SWG	250g reel **£34.99**

D Soldering Iron Kit

Antex soldering kit which includes CS18W soldering iron with silicone rubber cable and 13A mains plug, bench stand, starter pack of solder and "how to solder" booklet.

F4R05688	kit **£29.99**

E Soldering Iron Stand

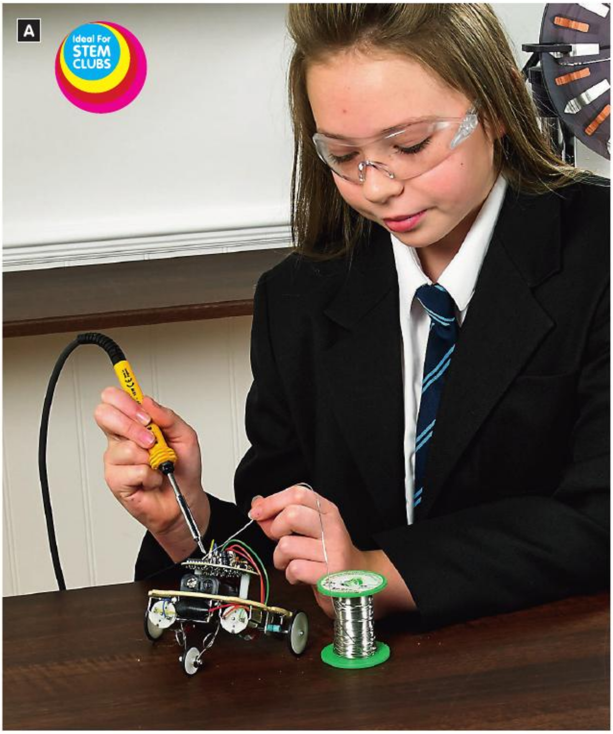
Strong chromium plated steel spring with a heat resistant plastic base. Integral sponge for cleaning bit. Ideal for soldering iron.

F4R05685	each **£5.99**

Soldering Stand Spare Sponge

Spare sponge for the Soldering Iron Stand.

F4R05686	each **£1.29**



A

B

C

D

E

A

Exceptional Science

Type	AA, LR6	AAA, LR03	9V, 6LR61	C, LR14	D, LR20
Voltage	1.5V	1.5V	9V	1.5V	1.5V
Code	F4R05730	F4R05731	F4R06104	F4R05733	F4R05734
Pack size	pack 10	pack 10	pack 10	pack 10	pack 10
Price	£2.99	£3.99	£8.99	£7.99	£9.99

B

Everyday Science

Type	AA, LR6	AAA, LR03	9V, 6LR61	C, LR14	D, LR20
Voltage	1.5V	1.5V	9V	1.5V	1.5V
Code	F4A05078	F4A05077	F4A04985	F4A04986	F4A04987
Pack size	pack 10	pack 10	pack 12	pack 12	pack 12
Price	£1.99	£1.99	£13.99	£8.99	£13.99

C

Economy Science

Type	AAA, R03	AA, R6	9V, PP3	C, R14	D, R20
Voltage	1.5V	1.5V	9V	1.5V	1.5V
Code	F4R05400	F4R05409	F4R05410	F4R05411	F4R05412
Pack size	pack 4	pack 4	each	pack 2	pack 2
Price	£0.59	£0.59	£0.69	£0.59	£0.99

Professional Alkaline Battery

A Advanced Industrial Alkaline Battery

Advanced, longer life professional Alkaline brand. Industrial by Duracell, the replacement for Procell.

- Ideal for any device
- Improved performance
- Ultimate trusted energy source
- 7 year shelf life
- Guaranteed against leakage
- Packed in reclosable boxes

Alkaline Batteries

B General Purpose Batteries

Premium general purpose battery:

- Excellent performance in the widest range of devices
- Ideal for audio devices and projects
- 7 year shelf life
- Guaranteed against leakage

Best Value for Low Usage Items

C High Power Zinc Chloride Batteries

The economy alternative for low usage or low power consumption appliance.

- Ideally suited for clocks, calculators and remote controls
- 3 year shelf life
- Guaranteed against leakage

Rechargeable for Less Waste

Lithium Batteries

D Energizer Lithium for Digital Cameras

Ultimate Lithium AA and AAA batteries offer the highest capacity for the size in the latest high power digital devices

- Up to 7 times longer lasting in digital cameras
- Ideally suited for DVD players, MP3 players, GPS systems and high intensity torches
- 15 year shelf life
- Excellent low temperature performance
- Lightweight

E Rechargeable Nickel Metal Hydride Batteries

Protect the environment by producing less waste - and at a lower cost!

- Can be recharged hundreds of times
- Ideal for heavy users and high drain devices - digital audio, motor powered, cameras
- Capacities: AA 2000mAh, AAA 850mAh, C and D 2500mAh, 9V 175mAh

Images for illustration purposes only.

D

Type	AA, LR6	AAA, LR03
Voltage	1.5V	1.5V
Code	F4A04998	F4A04999
Pack size	pack 4	pack 4
Price	£9.99	£9.99

E

Type	AA, HR6	AAA, HR03	9V, HR22	C, HR14	D, HR20
Voltage	1.2V	1.2V	9V	1.2V	1.2V
Code	F4A02103	F4A04992	F4A04993	F4A04994	F4A04995
Pack size	pack 4	pack 4	each	pack 2	pack 2
Price	£7.99	£9.99	£9.99	£9.99	£9.99

1, 2, 3, 4

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3-way Switch 22
3cm Wave Apparatus 53
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BUSINESS TO BUSINESS TERMS AND CONDITIONS

Please read these terms and conditions carefully before ordering any Goods for your business. You should understand that by ordering any of our Goods, you agree to be bound by these terms and conditions.

1. INTERPRETATION

1.1 The definitions in this condition apply in the terms and conditions set out in this document:

Force Majeure Event: has the meaning given in condition 10.
Goods: the products that we are selling to you as set out in the Order.
Order: your order for the purchase of our products.
Order Confirmation: has the meaning set out in condition 2.6.
Terms: the terms and conditions set out in this document.
Writing or written: includes faxes and e-mail.

1.2 Headings do not affect the interpretation of these terms.

1.3 These Terms shall only apply to the sale of Goods to businesses within the United Kingdom and Northern Ireland excluding the Channel Islands and BFPOs. Alternative terms and conditions are available for the sale of Goods to consumers and for customers outside of the United Kingdom and Northern Ireland.

2. BASIS OF SALE

2.1 These Terms, the Order and our price list set out the whole agreement between you and us for the sale of the Goods. Please check that the details in the Terms or on the Order are complete and accurate before you commit yourself to the agreement. If you think that there is a mistake, please make sure that you ask us to confirm any changes in writing, as we only accept responsibility for statements and representations made in writing by our authorised employees and agents. Please ensure that you read and understand these Terms before you sign and submit the Order, because you will be bound by the Terms once a Contract comes into existence between us, in accordance with condition 2.6.

2.2 These Terms apply to the agreement to the exclusion of any other terms that you seek to impose or incorporate, or which are implied by trade, custom, practice or course of dealing.

2.3 Any samples, drawings, descriptions or advertising we issue, and any descriptions or illustrations contained in our catalogues or brochures, are issued or published solely to provide you with an approximate idea of the Goods they describe. They do not form part of the contract between you and us or any other contract between you and us for the sale of the Goods.

2.4 If any of these Terms are inconsistent with any term of the Order, the Terms shall prevail.

2.5 The Order is an offer by you to enter into a binding contract, which we are free to accept or decline at our absolute discretion.

2.6 When you submit an Order to us on our website you will receive an email acknowledging your Order ("Order Confirmation.") The Order Confirmation does not constitute acceptance of the Order by us. Your order is accepted and a contract is formed between you and us when we despatch the goods you have ordered and not before. Until the goods are despatched the order may not be accepted by us.

2.7 A delivery note will be sent to you by email when your items have been despatched. If your Order is despatched in more than one parcel, you may receive separate delivery notes for each parcel, and each delivery note and corresponding despatch will conclude a separate contract of sale between us for the product(s) ("Contract") specified in that delivery note. Any Goods supplied will conform to the Contract.

2.8 Any quotation for the Goods is given on the basis that a binding contract shall only come into existence in accordance with conditions 2.6. A quotation shall be valid for a period of 30 calendar days from its date of issue, unless we notify you in writing that we have withdrawn it during this period.

2.9 We shall assign an order number to the Order and inform you of it in the Order Confirmation or delivery note. Please quote the order number in all subsequent correspondence with us relating to the Order.

2.10 We have the right to revise and amend these Terms from time to time. Please ensure you are familiar with the up to date Terms prior to placing an Order. If you require an up to date copy of the Terms please request one from our customer services department. You will be subject to the policies and terms in force at the time that you Order the Goods from us, unless any change to those policies or these Terms is required by law or government or regulatory authority (in which case, it will apply to Orders you have previously placed that we have not yet fulfilled).

2.11 Some products within the catalogue and contract accounts are exempt from promotional discounts at our sole discretion. Please ask our customer service department for details.

3. OUR GUARANTEES

3.1 We warrant that on delivery the Goods shall:

3.1.1 be of satisfactory quality;
3.1.2 be free from material defects in design, material and workmanship; and
3.1.3 comply with all applicable statutory and regulatory requirements for selling the Goods in the United Kingdom.

3.2 This warranty does not apply to any defect in the Goods arising from fair wear and tear, wilful damage, accident, negligence by you or any third party, if you use the Goods in a way that we do not recommend, your failure to follow our instructions, or any alteration or repair you carry out without our prior written approval.

3.3 These Terms apply to any repaired or replacement Goods we supply to you in the unlikely event that the original Goods are faulty or do not otherwise conform with these Terms.

3.4 Except as set out in these Terms all warranties, conditions and other terms implied by statute or common law are, to the fullest extent permitted by law, excluded.

4. DELIVERY

4.1 (a) **Next Day Delivery:** Orders of stocked items placed by phone and fax by 2pm with the request of next day delivery will be delivered free and aim to be delivered next day.

(b) **Standard Delivery:** Orders of stocked items will be delivered free and aim to be delivered within 2-4 working days.

(c) **Direct Despatch:** We aim to ensure that items dispatched directly from the manufacturer are delivered to you within 21 days of our receipt of your Order. Large or heavy Goods may take longer to deliver. Please allow extra time for deliveries to the Scottish Highlands, Scottish Islands, Northern Ireland, Isle of Man and Isle of Wight. In peak times delivery times may extend to 8 weeks, however we will endeavour to notify you of such extension at the time of placing your Order. All of these estimates are dependent on us/our manufacturers having the relevant Goods in stock at the time of your Order. Direct delivery items may incur a charge. You will be informed of any additional charges at the time of ordering.

(d) Please note that certain chemicals will be subject to a delivery charge. The affected products are clearly marked on the catalogue page.

4.2 Delivery of the Order shall be completed when we deliver the Goods to you.

4.3 We will take reasonable steps to meet any estimated delivery date. However delivery times cannot be guaranteed, for example, occasionally, delivery may be affected by factors beyond our control including the failure of our agents or subcontractors.

4.4 If we fail to deliver our Goods you must notify us within 7 days of the estimated delivery date. Any claim made after the 7 day period will not be accepted. Our liability shall be limited to the direct costs and expenses that you incur in obtaining replacement goods of similar description and quality in the cheapest market available, less the price of the Goods. We shall have no liability for any failure to deliver the Goods to the extent that such failure is caused by a Force Majeure Event or your failure to provide us with adequate delivery instructions or any other instructions that are relevant to the supply of the Goods.

4.5 If you fail to take delivery of an Order, then, except where this failure is caused by our failure to comply with these terms or by an event beyond your control:

4.5.1 we will store the Goods until delivery takes place and may charge you a reasonable sum to cover storage, insurance and other expenses incurred and
4.5.2 we shall have no liability to you for late delivery.

4.6 If you have not taken delivery of the Goods within 2 weeks of our notifying you that they are ready, we may, after giving you reasonable prior notice in writing, resell or otherwise dispose of part or all of the Goods and, after deducting reasonable storage and selling costs, pay you for any excess over the price of the Goods or charge you for any shortfall below their price.

4.7 If we are not able to deliver the whole of the Order at one time due to operational reasons or shortage of stock, we will deliver the Order in installments. We will not charge you extra delivery costs for this. If you ask us to deliver the Order in installments, we may charge you extra delivery costs. Each installment shall constitute a separate contract. If we are late delivering an installment or one installment is faulty, that will not entitle you to cancel any other installment.

4.8 If upon delivery you discover that the Goods are damaged or have not been delivered in accordance with your Order then you must notify us of this within 7 days of delivery. If you fail to do so then we will not be obliged to remedy the defect.

5. NO HASSLE RETURNS AND RETURNS OF DEFECTIVE GOODS.

5.1 Subject to the limitations set out in condition 5.2 and the qualifications set out in this condition 5.1, we are happy to take a return of Goods for any reason and provide a full refund provided that:

5.1.1 you let us know that you wish to return the Goods within 14 days of delivery
5.1.2 the Goods are in their original form including all packaging, are unused and all seals are unbroken; and
5.1.3 you pay the costs of returning the Goods, including but not limited to those listed at condition 5.6

5.2 The returns policy set out in condition 5.1 above does not apply to (a) Goods that are substantially made up of materials that can be photocopied, (b) any bespoke Goods, (c) any Goods which contain living organisms or cultures, (d) dissection resources, (e) preserved specimens, (f) chemicals or (g) radioactive sources

5.3 In the unlikely event that the Goods do not conform with these terms, and the qualifications in condition 5.1 cannot be met, please let us know as soon as possible after delivery and in any event within 14 days. We will then authorise the return of the Goods and arrange to collect the Goods on a date agreed between us (please note that we will not be responsible for any delay caused by a third party carrier) OR ask you to return the Goods to us at our cost. Once we have confirmed that the Goods are faulty, we will:

5.3.1 provide you with a full or partial refund
5.3.2 replace the Goods or
5.3.3 repair the Goods.

5.4 These terms will apply to any repaired or replacement Goods we supply to you.

5.5 In the unlikely event that you consider that our service has fallen below your expectations, you may apply to us for our Service Satisfaction Voucher. We will assess your application and if we accept it, we will issue you with a Service Satisfaction Voucher.

5.6 For the return of direct delivery items a handling charge may be applied which you will be advised of at the time that the return is requested.

5.7 If you cancel your Order within the 14 day cancellation period, we will refund all payments received from you, including the costs of standard delivery. We may make a deduction from the refund for loss in value of any Goods supplied if the loss is the result of unnecessary handling by you. We will make the refund within 14 days after we receive back from you any Goods supplied or 14 days after you provide evidence that you have returned the Goods to us, if earlier. You will have to bear the direct cost of returning items to us. We will make the refund using the same means of payment as you used for the initial transaction, unless you have expressly agreed otherwise.

6. TITLE AND RISK

6.1 The Goods will be your responsibility from the time of delivery at the address stated in the Order.

6.2 Ownership of the Goods will only pass to you when we receive payment in full and cleared funds of all sums due for the Goods and any other Goods that we have supplied to you.

6.3 We can recover any Goods in respect of which ownership has not passed to you in accordance with clause 6.2 above at any time. You agree to, immediately following written request from us, allow us such access to the Goods (and to such premises as are required to access to the Goods) as is required by us in order to facilitate such recovery.

7. PRICE AND PAYMENT

7.1 Prices may vary to those that appear in our catalogue or website

7.2 The price of the Goods will be as set out in the quotation we provided to you or, if we have not provided a quotation or the quotation has expired, in our price list in force at the time we confirm your Order. Prices are liable to change at any time, but price changes will not affect orders that we have confirmed in writing.

7.3 Prices exclude VAT.

7.4 Unless otherwise specified, prices exclude delivery costs, which will be added to the total amount due.

7.5 It is always possible that, despite our best efforts, some of the Goods we sell may be incorrectly priced and we will, at our discretion, issue an errata list from time to time (also available on our website). Where the Goods' correct price is less than or higher than our stated price, we will charge the correct price when dispatching the Goods to you.

7.6 If you do not have a credit account with us payment for all Goods must be made in advance by credit or debit card or by cheque. We do not offer credit accounts to individuals, sole traders or partnerships with less than three partners.

7.7 If you have a credit account with us we may invoice you for the Goods on or at any time after the date we have delivered the Goods to you. The invoice will quote the order number. You must pay the invoice in cleared monies within the time specified on the invoice or specified elsewhere by us to you. In any event (and in the absence of any other notification) such time shall be no longer than 30 calendar days from the date of the invoice. Please note that payment pursuant to this clause 7.7 shall only be permitted at our absolute discretion and we reserve the right to require upfront payment at any time.

7.8 If you do not make any payment due to us by the due date for payment (as set out in condition 7.7), we may charge interest to you on the overdue amount at the rate specified in the Late Payment of Commercial Debts (Interest) Act 1998 as amended from time to time. This interest shall accrue on a daily basis from the due date until the date of actual payment of the overdue amount, whether before or after judgement. You must pay us interest together with the overdue amount.

7.9 Without limiting any other remedies or rights that we may have, if you do not pay us on time, we may cancel or suspend any other outstanding Order until you have paid the outstanding amounts.

7.10 Prices may vary from those published in our catalogue or on our websites.

8. PRICE MATCH PROMISE

8.1 In the event that you find a cheaper price for an item that is the same as one of our products in any other current mail order catalogue for business to business purposes, we will match the price subject to the below terms.

The Price Match Promise only applies to:

8.1.1 Orders where you notify us of the cheaper competitor price at the time of placing your Order with us
8.1.2 competitor prices which are current and made generally available to all business customers
8.1.3 items sold within the UK by UK based companies
8.1.4 items which are not subject to any special promotional or discounted offers including without limitation using coupons, vouchers, member's discounts or trade discounts
8.1.5 items which are in stock and available on the same terms, where the invoice is paid in full and including any warranty
8.1.6 the item itself and not to delivery or any other services

8.2 Proof of price must be provided including current published price list, catalogue page or such other proof as we reasonably require. We reserve the right to verify any prices with the vendor.

8.3 Our Price Match Promise cannot be used in conjunction with any other promotion, discount or offer. Items sold as part of a multi-deal are matched to their individual price.

9. LIMITATION OF LIABILITY

9.1 Subject to condition 9.3 we shall only be responsible for losses which are a direct consequence of our failure to comply with these Terms and our total liability to you for all direct, proven and reasonable losses arising under or in connection with a Contract whether in contract, tort (including negligence), breach of statutory duty, or otherwise, shall not exceed the price paid or payable for the Goods.

9.2 We shall not be responsible for losses that you suffer as a result of our failure to comply with these Terms that fall into the following categories:

9.2.1 loss of income or revenue
9.2.2 loss of business
9.2.3 loss of anticipated savings
9.2.4 loss of data or
9.2.5 any waste of time.

9.3 We do not limit or exclude our liability for:

9.3.1 death or personal injury;
9.3.2 fraud or fraudulent misrepresentation; or
9.3.3 any other matter for which it would be illegal or unlawful for us to exclude or attempt to exclude our liability.

9.4 You are responsible for the selection and safe use of any chemicals that you order from us and to the extent that any losses you suffer from such chemicals result from your default, we shall not be responsible.

9.5 Except for the warranties expressly set out in these Terms we do not make any other warranties or representations with regard to the Goods. To the extent that we are not prohibited from doing so by law we hereby exclude all warranties which are implied into these Terms whether by legislation or otherwise.

10. EVENTS OUTSIDE OUR CONTROL

10.1 We will not be liable or responsible for any failure to perform, or delay in performance of, any of our obligations under these Terms that is caused by events outside our reasonable control (a "Force Majeure Event").

10.2 A Force Majeure Event includes any act, event, non-occurrence, omission or accident beyond our reasonable control and includes, in particular (without limitation), the following:

10.2.1 strikes, lock-outs or other industrial action
10.2.2 civil commotion, riot, invasion, terrorist attack or threat of terrorist attack, war (whether declared or not) or threat or preparation for war
10.2.3 fire, explosion, storm or other adverse weather, flood, earthquake, subsidence, epidemic or other natural disaster
10.2.4 impossibility of the use of railways, shipping, aircraft, motor transport or other means of public or private transport or
10.2.5 impossibility of the use of public or private telecommunications networks.

10.3 Our obligations under these Terms are suspended for the period that the Force Majeure Event continues, an we will have an extension of time to perform these obligations for the duration of that period. We will take reasonable steps to bring the Force Majeure Event to a close or to find a solution by which our obligations under these Terms can be performed despite the Force Majeure Event.

11. EXCLUSIVE GOODS

Goods which are described as being exclusive are exclusive to Findel Education Limited (Company Number: 1135827).

12. DATA PROTECTION

We shall comply with our obligations under the Data Protection Act 1998. We may record your calls for quality and training purposes.

13. DISPOSAL OF WASTE ELECTRICAL EQUIPMENT

We are committed to promoting the re-use, recycling and recovery of WEEE products by contributing to the VALPAK compliance scheme. WEEE products or packaging will be marked with a crossed out wheelie bin symbol to indicate that the Goods should not be disposed of in general domestic waste but disposed of through an approved WEEE scheme. For more information please see our website or call 03451 20 45 20.

We do not accept any liability whatsoever for the remote collection, shipping costs or packaging of returned Goods. All costs associated with the return of WEEE will be your responsibility.

14. ASSIGNMENT

You may not transfer any of your rights or obligations under these Terms to another person (including a corporate body) without our prior written consent, which we will not withhold unreasonably. We can transfer all or any of our rights and obligations under these Terms to another organisation, but this will not affect your rights under these Terms.

15. NOTICES

All notices sent by you to us must be sent to **Unilab, 2 Gregory Street, Hyde, Cheshire, SK14 4TH**. We may give notice to you at either the e-mail or postal address you provide to us in the Order. Notice will be deemed received and properly served 24 hours after an e-mail is sent or three days after the date of posting of any letter. In proving the service of any notice, it will be sufficient to prove, in the case of a letter, that the letter was properly addressed, stamped and placed in the post and, in the case of an e-mail that the e-mail was sent to the specified e-mail address of the addressee.

16. GENERAL

16.1 If any court or competent authority decides that any of the provisions of these Terms are invalid, unlawful or unenforceable to any extent, the Term will, to that extent only, be severed from the remaining Terms, which will continue to be valid to the fullest extent permitted by law.

16.2 If we fail, at any time while these Terms are in force, to insist that you perform any of your obligations under these Terms, or if we do not exercise any of our rights or remedies under these Terms, that will not mean that we have waived such rights or remedies and will not mean that you do not have to comply with those obligations. If we do waive a default by you that will not mean that we will automatically waive any subsequent default by you. No waiver by us of any of these Terms shall be effective unless we expressly say that it is a waiver and we tell you so in writing.

16.3 A person who is not party to these Terms shall not have any rights under or in connection with them under the Contracts (Rights of Third Parties Act 1999).

16.4 These Terms shall be governed by English law and we both agree to the exclusive jurisdiction of the English courts. Please note that we only accept orders from addresses outside the UK on our International Terms which are available on request.

16.5 Please note that we only accept Orders from addresses outside the UK on our International Terms which are available on request.

UNILAB®

Order Form

FREE NEXT DAY DELIVERY
Order before 2pm†

PRICE MATCH PROMISE
If you find the same item cheaper elsewhere, we'll match it!†

HASSLE FREE RETURNS
Return Items for free, simply let us know within 7 days†

Account No:
Customer Order Ref/PO:
Establishment Name:
Establishment Address:
Postcode:
Contact Name:
Telephone No:
Email Address:

Easy ways to order

Call us on: **0345 120 4521**
8am-5:30pm Monday-Friday

Shop online at:
www.unilab.co.uk

Freefax us on: **0800 138 8881**

Email us at:
orders@unilab.co.uk

By post to: **Unilab, 2 Gregory Street, Hyde, Cheshire, SK14 4TH**

Delivery Address (if different):
Postcode:

Invoice Address (if different):
Postcode:

Special Instructions (please advise us of school holidays):

Please let us know your job title and email address so we can keep you updated on your order

Name: Job Title:
Email Address:
☐ **Tick here to receive great deals and exclusive offers directly to your inbox**

Payment Methods **Please tick your preferred payment option:**

☐ **Invoice** Tick here if you are happy to receive your invoice by email ☐
☐ **Credit/Debit Card** For security purposes we will contact you by phone to confirm details when processing your order
☐ **Cheque** If you are enclosing a cheque please make it payable to Unilab

Page	Product Code	Product Description	Qty	Unit Price (Exc VAT)	Total Price (Exc VAT)

I have a **promotion** code to quote: ☐

Please tick for FREE NEXT DAY DELIVERY ☐ (Orders must be placed before 2pm)†

Remember: VAT will be added to your order at the appropriate rate

Please note we make every effort to maintain the prices in this catalogue but prices are subject to change due to volatile raw material costs.
† See terms and conditions.

Total value of goods exc. VAT	£ .
Please add VAT to your total order value for all items	£ .
Total Order Value	£ .

Thank you for your order

UNILAB®

Order Form continued

FREE NEXT DAY DELIVERY
Order before 2pm†

PRICE MATCH PROMISE
If you find the same item cheaper elsewhere, we'll match it!†

HASSLE FREE RETURNS
Return Items for free, simply let us know within 7 days†

Easy ways to order

Call us on: **0345 120 4521**
8am-5:30pm Monday-Friday

Shop online at: **www.unilab.co.uk**

Freefax us on: **0800 138 8881**

Email us at: **orders@unilab.co.uk**

By post to: **Unilab,
2 Gregory Street, Hyde,
Cheshire, SK14 4TH**

Establishment Name: **Account No:** **Postcode:**

Page	Product Code	Product Description	Qty	Unit Price (Exc VAT)	Total Price (Exc VAT)

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